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Observations on the Life History and Development of *Leptodactylus albilabris*

JAMES NORMAN DENT

ALTHOUGH frogs of the family Leptodactylidae have a wide distribution in the tropics and subtropics of the Americas there is little published information concerning their life histories and modes of development. This paper extends and enlarges upon the information presented by Stejneger (1904), Schmidt (1920), and Orton (1951) on the reproduction and young of *Leptodactylus albilabris* (Günt[illegible] observations and collections we[illegible]n 1943 during service with th[illegible]ir Forces at Ramey [illegible] called Borinquen Field) [illegible]ner (Punta Borinquen) five miles north of the [illegible] material studied came [illegible]mey Air Force Base. [illegible]p. cit: 579) found the [illegible]n "a compact ball of snowy foam of a somewhat gelatinous consistency" beneath a stone in the water of a small stream. Schmidt (op. cit.) discovered three foam-filled nests, one beneath a large stone at the edge of a creek, another underneath a stone on a hilltop where there was no water in the vicinity, and a third under a rotten log beside a pool of standing water. About 30 nests containing embryos and an almost equal number of empty nests (i.e., which contained neither eggs nor foam) were examined. These nests were typically subspherical cavities hollowed out of soft earth. They were about 3 cm. in depth and 6 cm. in greatest diameter. As was true of the nests observed by Schmidt, the walls were smooth with no markings to indicate the manner of excavation. When eggs were present, the nests were completely filled with egg-foam masses like that described by Stejneger. One of the nests containing eggs was located under a stone beside a small stream. Three others were found beneath fallen palm fronds and palm debris in a swampy area. The remainder were within a meter or two of the edge of a small pond (approximately 10 meters in diameter), the water level of which fluctuated considerably with variation in rainfall. The nests found beside this pond were of three types; covered by (a) vegetable debris, (b) stones, and (c) domes of earth. Only three nests of type *b* were found. Types *a* and *c* were in approximately equal numbers. Each nest of type *b* was situated five or more centimeters within the outer border of the zone of contact between the stone and the earth. The edges of such cavities were in close contact with the stone and there was no indication of the route by which the adults emerged from the nest after the laying of the eggs. The nests of type *c* were seen externally merely as small rounded elevations of earth about a centimeter or a half centimeter in greatest height. The thickness of the layer of earth covering the foam was about 0.5 cm. These nests resembled those described by Lutz (1947) for *L. nanus* except that their domes had no apical openings. The description of nest-building and egg-laying given by Cei (1949) for *L. bufonius* may hold also for *L. albilabris*. The female of *L. bufonius* digs the nest cavity with her hind legs and remains within it calling for the male until he arrives. The male clasps the female while she is within the nest and as the eggs and jelly are extruded manipulates them with his hind legs until the cavity is filled. Afterwards the pair carefully cover the nest with earth and depart. The nest of *L. bufonius* is pyriform rather than subspherical in shape.

When empty nests were found, there was usually evidence of their having been submerged during recent flooding of the adjacent pond or stream. Schmidt (op. cit.: 170) states, "It is evident that the tadpoles [before metamorphosis takes place] will be washed from the nest into the adjacent water by a flood or heavy rain." A few of the empty nests of type *c* opened to the outside by means of short tunnels about 2 cm. in diameter. Whether the larvae metamorphosed and dug their

way out or a predator entered and consumed the embryos was not ascertained. The largest larvae found in the nests were some 12 mm. in length and it seems likely that the larvae ordinarily enter the water long before metamorphosis is complete.

It seems unlikely that metamorphosis is ever completed within the nest. Two batches of eggs with their surrounding foam were put into petri dishes. As the embryos reached the swimming stage the foam gradually liquified. The larvae moved about in the liquid and grew to 15 mm. in length, but in the course of about 30 days regressed somewhat in size and died. No food was supplied the larvae in the petri dishes and it is doubted that any appreciable amount would be present in the nests. Although the yolk mass of the *L. albilabris* embryo is relatively large, it only carries the embryo through the early larval phase. Vinton (1951) conducted a similar experiment with larvae of *L. pentadactylus* and concluded that the larvae of that form would starve before metamorphosis if they were not released from the nest. Lutz (op. cit.) states that larvae of *L. nanus* metamorphose within their nests. The eggs of that species are often laid some distance from water whereas those of *L. albilabris* (except in very rare instances) were always found in sites which were intermittently flooded.

Breeding Season.—Stejneger (op. cit.) suggested that the breeding season of *L. albilabris* is early in the year since he found a metamorphosing individual on February 20, full grown tadpoles on March 1, and embryos and tadpoles at all stages of development on April 7. Schmidt (op. cit.) found nests containing embryos or larvae on August 27, 29, and October 1. The present author found nests with recently laid eggs (embryos not yet at the neurula stage) on April 20, May 8, 30, August 15, September 22, and December 15. It thus appears that this form lays throughout the year. The relatively stable climate of Puerto Rico would seem to encourage this habit.

Early Development.—Embryos and larvae from 8 clutches of eggs laid at different times and representing various stages of development were fixed in Bouin's solution. Additional observations were made on living animals. It is well known that temperature is an important factor in the rate of amphibian development, but the annual temperature variation is not great in Puerto Rico and the time sequence given for the development of *L. albilabris* in the following paragraphs is probably fairly similar in all seasons.

Schmidt (op. cit) describes the eggs of *L. albilabris* as being light yellow and as having a diameter of 2.5 mm. to 3 mm. The early embryos described here have a mean diameter of 2.1 mm. and, making allowance for shrinkage produced by fixation, their measurements, when alive, probably would have been close to Schmidt's figures. They were encased in thin, transparent, tough, gelatinous membranes. Lacking proper optical equipment no observations were made on the processes of cleavage and blastopore formation.

In the neurula stage (Fig. 1) which is reached on the second day after laying, the length of the medullary plate relative to the circumference of the yolk mass is somewhat shorter than that of *Rana pipiens* at stage 14 (Shumway, 1940). The lateral lips of the blastopore have approached one another but have not fused. After the neural tube has been formed, at the beginning of the third day (Fig. 2A), the embryo is strikingly different in appearance from that of *R. pipiens* at an equivalent stage (stage 16). The proportionate difference between the yolk mass and the differentiating axial structures is

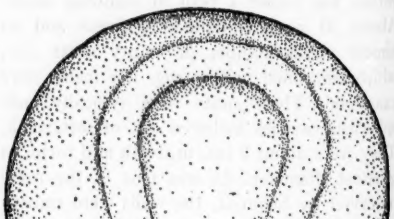

Fig. 1. Embryo at the neurula stage (1½ days old).

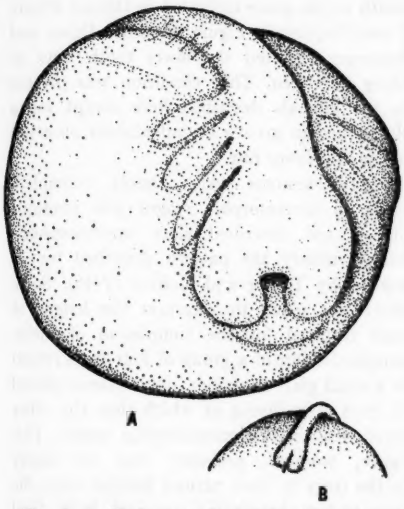

Fig. 2. A. Embryo early in the third day of development. Sense and gill plates are prominent. B. Posterior view of the same embryo. Note paired tailbud.

much greater in *L. albilabris* than in *R. pipiens*. A bifurcated sense plate stands out markedly at the cephalic end. It is flanked by the first of three pairs of clearly defined ridges or gill plates. Five or six pairs of myotomal segments flank the central region of the neural tube and a proctodaeum and paired tail bud rudiments are visible posteriorly (Fig. 2B). The presence of a paired tail rudiment is certainly very unusual and may be peculiar to *Leptodactylus*.

Early in the third day the differentiation of the tail bud begins. Its two halves come together and fuse. As the tail begins to elongate the caudal fin develops and is extended craniad along the posterior trunk region as the dorsal fin. The serial differentiation of the myotomes (there are 12 to 14 pairs at this time) continues posteriorly on the trunk and late in the third day progresses to the tail. Except for the five or six most anterior pairs the myotomes are chevron-shaped. Changes in the head region seen at the beginning of the third day include the outgrowth of the optic vesicles and the thinning of the roof of the fourth ventricle. The gill plates are now directed more nearly craniad and are almost parallel to the sense plate which is increasing in size.

During the third day (Fig. 3) the tail increases in length to approximately 2.5 mm. and some 20–25 pairs of myotomes differentiate within it. A bulge representing the pronephros appears lateral to the first three myotomes. Outlines of the otic and optic vesicles become apparent. Gill buds develop on the first and second gill plates and those of the first form secondary buds. A groove divides the sense plates into medial and lateral portions. The medial portions lie close together distally where the lower jaw will eventually form, but are separated proximally by a depression which includes dorsally the hypophyseal pit and ventrally the presumptive stomodaeum. Toward the end of this period (Fig. 3) the stomodael pit spreads laterally as the mouth begins to form. In living animals the heart and muscles of the trunk and tail begin contracting during the third day.

Hatching occurs on the fourth day. The foam surrounding the eggs begins to liquify and after the young larvae emerge from their egg membranes they move freely about within it. Figure 4 illustrates the morphological features which are visible externally at this

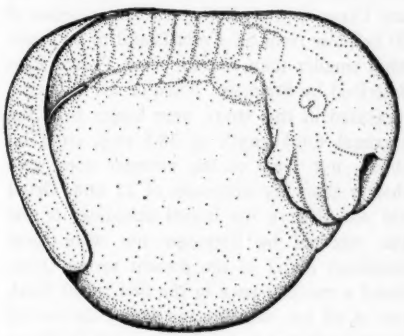

Fig. 3. Three-day-old embryo.

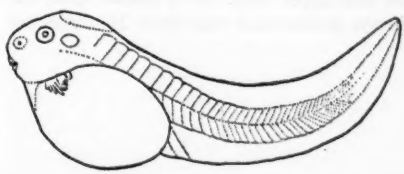

Fig. 4. Embryo at hatching.

time. The mouth opening has been formed and lips have developed. Nasal pits have appeared. The gills are further subdivided and lengthened and are covered at their bases by the developing opercular fold. Dorsally, melanophores are apparent in the anterior trunk region. The yolk mass has lost its spherical form, has been reduced somewhat in size, and has become elipsoidal. The tail has reached a length of approximately 3.5 mm.

LARVAE.—Definitive larval form is attained during the two days following hatching. The lips thicken and labial papillae form. Tooth ridges and beaks appear on the fifth day and labial teeth are present on the sixth day. The opercular fold becomes more pronounced and completely encloses the gills by the sixth day. A spiracle opens from the left side of the opercular cavity. The eyes become pigmented. Intestinal coiling begins on the fifth day and is quite marked on the sixth. The hind limb buds are apparent on the fifth day and by the sixth day correspond to those of *R. pipiens* at stage 3 of Taylor and Kollros (1946). The total length is now approximately 11 mm.

The larva of *L. albilabris* has been discussed and described in detail by Stejneger (op. cit.) and Orton (op. cit.). Orton found a series of 40 tadpoles from St. Croix Island to be somewhat smaller than the one from Puerto Rico described by Stejneger. None of the 56 larvae measured in this study were longer than the maximal total length of 38.5 mm. cited by Orton, but some of the younger ones were shorter than her minimum of 22 mm. Orton did not observe the lateral infoldings of the lips reported by Stejneger nor were these infoldings found in the present series. Orton found a median space in the first upper tooth row of all her tadpoles and found the second upper tooth row to be discontinuous in 24 out of 40 animals. In the present series the second upper tooth row was uniformly unbroken. In the first upper tooth row a median space was always present and was about 2½ times the width of the space indicated in Orton's Figure 3 and Stejneger's Figure 14. Both Orton and Stejneger reported the lower tooth rows as being unbroken. That condition was present in the animals described here except for a slight median groove or indentation observed in the first lower row.

METAMORPHOSIS.—An almost complete series of metamorphic stages was obtained but is not described since metamorphosis follows closely the pattern described for *R. pipiens* by Taylor and Kollros (1946). Some effort was made to ascertain the length of time required for the completion of metamorphosis. Out of a group of four frogs reared in a small glass container, one metamorphosed 73 days after laying at which time the other three were in late metamorphic stages. This figure, however, probably does not apply to the frogs in their natural habitat since the four under observation received little food and were considerably emaciated. An estimate of 35 days would probably be more accurate.

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DEPARTMENT OF BIOLOGY, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, VIRGINIA

Sidewinding Locomotion in Snakes

RAYMOND B. COWLES

THERE is a widespread belief that the curious horizontal broadside movement of *Crotalus cerastes*, known as "sidewinding" is a specific adaptation to locomotion on the sandy surfaces of the desert. The persistence of this theory results in part at least from acceptance of the assumption that there is an actual advantage in this "rolling" type of movement as opposed to the conventional and supposedly less efficient sinuous means of progression.

In the rolling, "sidewinder," locomotion that simulates the motions of the flattened coils of a helix, (Mosauer, 1932; Van Riper, 1955) action and reaction forces usually are spread over two segments of the body rather than several separate, smaller body loops. Since to move any body of given mass will require the same thrust against the ground, it might be argued that many separate thrust points would prove more efficient on unstable slopes with shifting ground than would the same amount of thrust when combined and applied by only two segments as in sidewinding. If there is any real advantage to sidewinding it might lie in the difference between amount of friction during movement of the snake's belly against sand and reduction of this by the "rolling" movement of the sidewinder. Because of the glossy surface of the gastrosteges and the light weight of the body as contrasted with the mass of the sand required to withstand the thrust, it is highly dubious if sidewinding is actually any more efficient on loose sand than the standard sinuous movement. In fact it might be demonstrably, but minutely less efficient.

I have made no exhaustive search of the literature to discover the origin of the term sidewinding nor the first instance of ascribing to it more effective locomotion on sand. However, it seems probable that Cope may have been the first to mention the term in technical literature. He reports the discovery by Dr. J. L. Wortman of the identity of the snakes referred to as "sidewinders" by Arizonans, but he says nothing regarding this type of locomotion as being an adaptation to loose sand. Ditmars (1907) says "Here we see Nature's admirable provision to enable a heavy-bodied snake to progress at some speed over desert sands. That this is the *only* fashion in which a thick-bodied snake could display agility on soft soil is well illustrated by the fact that their singular movements have been adopted by the vipers of the African deserts and again far removed from them, by our one species of rattlesnake that inhabits the deserts proper." (The italics are his.) Later workers have shifted the emphasis from speed to the soft soil aspect, but Ditmars emphasis on speed may be nearer the truth.

Pope (1937: 19, 111) possibly following Mosauer (1932), merely alludes to this trait as an adaptation to travel on loose sand. Gloyd (1940) mentions the desert adaptations of our sidewinding rattlesnake, but he does not fall into the positive error of accepting shifting sand as the prime cause for the success of this peculiar locomotion. Stebbins (1954) carefully notes that this snake is not restricted to "wholly sandy situations, for it has been found on bare hardpan and in areas where there are scattered rocks on firm soil. Usually, however, some sand is present nearby." He also mentions its presence on sand hills and rocky hillsides as at Lovejoy Buttes on the Mojave Desert, and he circumspectly states that "an advantage of this type of locomotion may be to minimize slippage on a shifting surface," and calls attention to the fact that the locomotory forces are applied vertically to the surface on which the snake is traveling.

Cowles (1920), quoted in extenso by Van Denburgh (1922), plunged headlong into the pitfall of what may prove to be the seemingly obvious, and ascribed to this type of locomotion a specific adaptation to movements over a sandy, hence a yielding, and for conventional ophidian motion, a nearly tractionless surface. Since 1919 and 1920, years of growing familiarity with the sidewinder, that is, throughout the last 35 years since publication of the 1920 paper from which Van Denburgh quoted, there have been many occasions

for rueful contemplation of youthful conclusion-jumping.

The actual facts regarding the methods of sidewinding have been stated well by Mosauer (ibid), but the commonly supposed reason for this anomalous type of locomotion, the shifting substratum and consequent loss of traction by normal, i.e. horizontal undulatory progression appears to be at variance with some observed facts. Snakes of the genera *Pituophis*, *Rhinocheilus*, and *Arizona*, as well as *Crotalus atrox*, among the heavier species of desert-inhabiting snakes, have all been observed conducting apparently unhampered effective movement on wind-blown sand. The smaller, lighter species of the genera *Chionactis*, *Phyllorhynchus*, and *Hypsiglena*, as well as numerous small juveniles of the heavier species are apparently unhindered in their standard locomotion, even when moving at an accelerated pace. It is seemingly only when frightened or otherwise driven to frantic escape movements that surface slippage becomes apparent in the heavy-bodied snakes. In other words, it is only when dire emergency demands utmost speed that this factor of slippage assumes importance. Consideration of the circumstances that might call for these frantic movements suggests only attack by a predator, or, probably of far greater frequency in the lives of these animals, being caught out in a wide open space when temperatures from solar radiation and conduction from the hot ground might jeopardize survival. It is well known to students of desert life that *C. cerastes* is not infrequently caught under these conditions. The habit of edging out "saucer-like" depressions in loose sand and remaining there until the surroundings become lethally hot has been observed on a number of occasions. On being evicted from such a shallow depression and placed on the hotter sand close by, the sidewinder sidewinds to the nearest shade with truly surprising celerity. These movements might be described as nearly, but not quite, leaping, and the total effect as "loping" or "galloping". If prevented from reaching shade of some kind, the animal dies rather quickly, the rate being determined by its surface-volume ratio and the degree of heat at the ground surface.

Most of the above-mentioned snakes are either prowlers of the scattered desert vegetation and the networks of rodent burrows that are so characteristic of the ground around the base of desert perennial plants, or they are sand-swimmers, with secure heat shelter or concealment always so to speak "at their feet" wherever they move. In such habitats sinuous movements are the most efficient, in fact sidewinding either in the brush or in subsurface shelter under the sand obviously would be impossible.

Concerning the life of the sand-swimmers or the burrow inhabitants (Cowles 1941) it is interesting to note that much of the year, summer or winter, optimum or near optimum temperatures prevail for photophobic species either diurnally just below the surface on a sunny winter day and through the spring months, or at deeper levels in late spring or summer. Because so many nocturnal, photophobic animals have rather similar thermal boundaries and preferences, whether they are predators or prey, the daily and annual thermal tides in desert soils during at least part of the year should serve to herd both predators and their prey into some sort of juxtaposition between the rising and falling thermal boundaries. This is a situation that should be highly advantageous to the predator and especially to snakes with habits like those of *Chionactis*.

The significance of the degree to which sidewinders are associated with a terrain that permits their peculiar type of locomotion logically should have been apparent to the earlier speculators on the origins of the habit. Fine, shifting sand of the type required to support the old theory is localized in our southwestern deserts. It is chiefly aeolian and it is deposited in relatively few places, where winds have lost their carrying capacity. Such areas are limited in number and extent. Of the total area inhabited by *C. cerastes* an informed guess would suggest that possibly less than 1 percent of the surface is of loose sand. The really serious impediment to locomotion caused by steep-faced sand dunes where the soil is at the angle of rest, as on the recurved crescentic faces of barchan dunes, would be encountered in only a fraction of 1 percent of the total habitat.

Sidewinding is overwhelmingly associated with open terrain that is predominantly free

of protruding vegetation or obstructing rocks. All objects that protrude above the surface for more than a few centimeters effectively prevent broadside movement of any animal having a long horizontally oriented body, and only open areas irrespective of slipping sand surfaces would permit this novel type of locomotion.

Where open areas are the predominant feature of the terrain only sidewinders, *C. cerastes*, the sand-inhabiting North African genera *Aspis* (formerly *Cerastes*) and *Echis carinatus* and the South African *Bitis cornuta* and *B. caudalis* are known to sidewind. What appears to be sidewinding has been reported (Bogert 1947) in some members of the genera *Thamnophis* and *Natrix*, and in the Cuban boa *Tropidophis melanurus*. *Thamnophis e. hammondii* has been seen to sidewind on hard open ground (verbal communication, John Cunningham).

Because the sidewinding of *C. cerastes* is directly and imperceptibly translated into effective swimming movements when these snakes are driven from sand into water, and vice versa, and because of the simulated, possibly genuine sidewinding in some semi-aquatic snakes, it may be possible that the muscular and neural dynamics involved in swimming and sidewinding have common aspects. The subject should be investigated, but mention of the situation here is not meant to imply that sidewinders have evolved from aquatic associations or ancestors. Of all the North American crotalids they are probably the most perfect exemplars of crotalid adaptations to an arid environment.

In temperate zone deserts the untempered heat of large open spaces reaches levels unequalled even in the tropics. Soil temperatures as high as 87°C have been recorded by means of black bulb thermometers and small reptiles will die in a matter of minutes when exposed to the full thermal effects in an environment only inches from where they live. It is essential for all desert animals to be able to escape the full impact of the heat of their environment and in emergencies, as on a hot surface, it is known that at least some individuals of *Crotalus atrox*, *Phyllorhynchus* and *Hypsiglena* resort to at least approximations of sidewinding with *C. atrox* (one individual) giving a seemingly perfect duplication of sidewinding. It may be significant that under identical conditions *C. mitchelli*, an inhabitant of rocky desert areas, failed to equal the sidewinding of *C. atrox*.

As stated earlier, the genuine sidewinders are primarily inhabitants of extensive areas that are free of vegetation and, except for *Thamnophis*, they exist where maximum temperatures are the highest known. Associated nocturnal reptiles, lizards or snakes, are not actually dwellers on these hot areas but escape heat and surface predators by retreating underground. At most they venture across open ground only at night and they do so mainly in order to reach widely-spaced vegetation or to move from one patch of rocky terrain to another, or between one network of burrows and another. A few are restricted to patches of heavy vegetation in what might be termed oases. Because the habit is so widely encountered in desert animals, it is interesting that *C. cerastes* failed to evolve burrowing or sand-swimming as a means of modifying the impact of its thermal environment, but so far as known no crotalids seem to have evolved in this direction.

Since overheating will kill small snakes, including sidewinders, in a matter of minutes it may be that in order to have survived without burrowing or sand-swimming *C. cerastes* has profited in some way from this unusual locomotion. It attains high speeds, probably by far the highest observed in any of our pit vipers, and seemingly these speeds can be sustained for a longer interval than is possible by means of other more conventional movements. Of itself the advantage of high speed when moving over hot ground between patches of shade or rodent burrows should seemingly insure a greater chance of survival than would the slower gaits. An additional advantage derived from sidewinding might result from the fact that the total area of body contact with a hot substratum, often 60°C plus, is roughly halved as the body "rolls" over the ground. Although all points of the body will pass through the contact phase during a complete cycle, some of the body will always be in the air from which heat will be absorbed more slowly than from the ground.

Additional advantages would accrue to this speedy type of locomotion especially in the search for food when the snake moves from one rodent warren to another. In relatively barren areas, concentrations of food are of necessity rather widely scattered and danger from predators would come chiefly during passage over intervening open spaces in search of these feeding areas. The same advantage of speed would attend rapid locomotion while in search of a mate. Suggestive of this is the fact that on one occasion a large female sidewinder has been tracked for over ¼ of a mile, this distance representing part of a single night's travel. Over the observed route, three other snakes in apparently random movements, encountered the tracks left by this female. They then followed for a few yards and on reaching the female "scuffled" with her and separated once more. A fourth encounter between the female and a small male, ended in acceptance by the female, for the double tracks representing male pursuit soon merged to a single heavier track that ended in a rodent burrow where both male and female were collected. The cumulative total sidewinder movement to consummate this mating must have approximated a distance of over a mile of travel on the open surface of the ground. There can be little doubt but that sidewinding as a concomitant of residence in wide open spaces that permit only sparse populations, would facilitate a meeting of the sexes and notably reduce the amount of time spent while exposed to danger.

To summarize, it appears that sidewinding is primarily an adaptation permitting successful occupation of wide open spaces and the solution of problems associated with wide open spaces of smooth ground rather than being a specific device for successful locomotion on a shifting substratum.

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Department of Zoology, University of California at Los Angeles, Los Angeles, California

The Relationship between Hypoxia, Temperature, Adrenalin Release and Melanophore Expansion in the Lizard, *Anolis carolinensis*

H. Rahn

It is a well established fact that a lowering of the tension of inspired oxygen will cause the release of epinephrine from the adrenals of mammals. Poikilothermal animals are relatively resistant to hypoxia that in part may be attributed to reduced metabolism. Thus a relationship between the degree of hypoxia, temperature (metabolic rate), and the release of epinephrine is to be expected. It is this relationship that was investigated in the lizard, *Anolis carolinensis*, the so-called "chameleon" of our southern states.

In the anole lizard light reflected from the chromatophore system provides a sensitive index of the concentrations of two circulating hormones, namely the melanophore hormone from the pars intermedia of the pituitary and epinephrine of the adrenal glands (Kleinholz,

1938). A hypophysectomized anole is rendered permanently bright green since the melanophore pigments remain concentrated permitting the light to be reflected from the underlying xanthophores. The normal color changes observed from bright green to dark brown are related to the amount of melanophore expanding principle released. Various factors such as heat and light will inhibit or stimulate the release of this hormone from the pituitary and in continuous darkness a diurnal rhythm of hormone release can be observed during the solar day (Rahn and Rosendale, 1941). In the laboratory under conditions of moderate temperature and moderate light, anoles are usually dark brown.

Adrenalin, either injected or released from the animal's own glands, will concentrate melanophore pigment but not in a uniform manner. Instead of a uniform green color irregular patches will occur particularly on the legs and tail which reveal a blue-green mottling. With more intense stimulation this mottling will spread all over the body. One exception is a patch situated just behind the eyes. This responds by darkening and can be recognized even in a dark brown animal. This patch is most sensitive to adrenalin and is the first sign of adrenalin release. The adrenalin response can be easily evoked by simply handling the animal and one may quickly discern various stages which qualitatively reveal different degrees of adrenalin release. These signs have been used in a semiquantitative manner to gauge the amount of adrenalin released and 4 arbitrary stages have been recognized which reflect increasing adrenalin response. Stage 0, no adrenalin response, lizard dark brown; Stage 1, darkening of patch behind eye; Stage 2, blue-green mottling appearing on tail as well as on the feet below the elbows and knees; Stage 3, blue-green mottling over all the leg surfaces. Stage 4, blue-green mottling over all body surfaces. The adrenalin response is characterized by a blue-green mottling while the lack of melanophore expanding hormone is indicated by a uniformly bright green color. With a little experience it is easy to recognize the differences and to determine the arbitrary stages of the adrenalin signs.

The response to the melanophore expanding hormone can also be described in 4 stages from uniformly bright green, Stage 0, to uniformly dark brown (Stage 4) (Rahn and Drager, 1941).

Method

The animals were kept at temperatures of 14°, 20°, 25°, and 30°C and exposed for one hour to a particular oxygen tension. The color of each animal was recorded every 15 minutes. Animals were used only once a day for a particular temperature-oxygen combination experiment, and they were kept for several hours at a constant temperature prior to the exposure to low oxygen tension. Sixteen anoles were placed in a bell jar for one hour while air was continuously drawn through with a vacuum pump. This long equilibration time was necessary since the mere handling of animals was frequently sufficient to evoke an adrenalin response. After an hour their color was recorded and the air intake pipe closed. The pressure was then slowly reduced over a five minute period until the desired pressure was registered on an attached mercury manometer. At this new pressure the intake pipe was slightly opened so that the chamber was continuously supplied with fresh air. Color readings were made every 15 minutes for one hour.

The total pressures to which these animals were subjected were 747 (ground level control), 412, 270, 226, and 141 mm. of mercury. Table 1 shows the partial oxygen pressure at these levels as well as the equivalent altitude and also gives approximately the equivalent percentage of oxygen in an oxygen-nitrogen gas mixture which would be required to produce the same partial pressure of oxygen at sea level. Each pressure exposure was repeated at the four temperatures. The color responses of all 16 animals

TABLE 1

COLOR RESPONSE OF *Anolis carolinensis* AT DIFFERENT TEMPERATURES AND TENSIONS OF OXYGEN

Barometric pressure mm. Hg	P_{O_2} (dry)	Equivalent altitude (feet)	Equiv. % O_2 at 760 mm. Hg	Melanophore hormone response at different temperatures			
				14°	20°	25°	30°
747	156	500	20.9	3.6*	3.4	3.2	3.3
412	86	16000	11.3	3.6	3.2	2.8	2.5
270	56	26000	7.4	3.5	3.2	2.3	2.8
226	47	30000	6.2	3.6	3.8	2.6	2.4
141	30	40000	3.9	3.4	3.4	2.5	1.6
Mean				3.5	3.4	2.6	2.3

* Scoring explained in text.

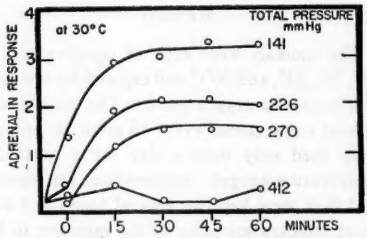

Fig. 1. Adrenalin response of 16 *Anolis carolinensis* to four different barometric pressures at a temperature of 30°C. Numbers indicating adrenalin response are color stages described in text.

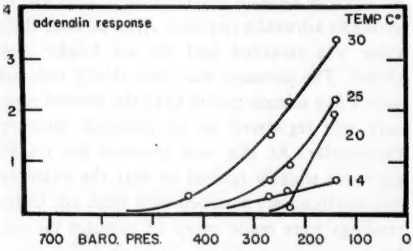

Fig. 2. Summary of experiments on color responses of *Anolis carolinensis* at different temperatures and partial pressures of oxygen. Numbers indicating adrenalin response are color stages described in text.

were averaged and the results are shown in Figs. 1 and 2, and Table 1.

Discussion

The melanophore expanding hormone response is tabulated in Table 1. With increase in temperature the animals became increasingly lighter independently of the partial pressure of oxygen to which they were exposed. These observations suggest that low oxygen tension does not interfere with the release of this hormone. That increasing temperature, per se, will reduce the melanophore expanding response has been well established by other workers.

The adrenalin response, on the other hand, is striking. Fig. 1 indicates the response of 16 animals which were exposed on different days to four different barometric pressures all at a temperature of 30°C. The response is prompt and seems to be inversely proportional to the partial pressure of oxygen. Once the response occurs it is maintained. Fig. 2 summarizes all the experiments at different pressures and temperatures. The adrenalin response recorded is that which was observed during the last 15 minutes of the one hour exposure. Each point represents the average response of 16 animals.

Table 2

Oxygen Uptake of *Anolis carolinensis* at Different Temperatures

Temperature	17°	25°	25°	27°	32°	32°
O_2 uptake—cc/gm. lizard	.075*	.161	.156	.194	.310	.434

* Each figure represents an average of 5 lizards

It is apparent that we have two factors which intensify the adrenalin response, namely an increase in body temperature and a decrease in partial pressure of oxygen. These seem to be additive. The increase in body temperature will increase the metabolic rate of these poikilothermal animals and may thus account for a proportional release of adrenalin for a given hypoxic stress. Their oxygen uptake was measured at various temperatures (Table 2) and shows over the range studied a Q_{10} of 2.6. The adrenalin response at a given partial pressure of oxygen is approximately proportional to metabolic rate for each temperature. This, however, may be fortuitous since the adrenalin response scoring is not necessarily linear to the adrenalin concentration. The possibility that pressure reduction, per se, might produce a stress, such as intestinal gas expansion, cannot be ruled out. However, such a stress does not release adrenalin. In two similar experiments at 141 mm. of mercury the animals were exposed to 25° and 30°C but, instead of air, 100 percent oxygen was drawn continuously through the animal chamber. In both instances the adrenalin response failed to appear.

I am greatly indebted to Mr. J. Holmes for his technical assistance.

Summary

The skin color of the anole lizard was used as an index of the release of both adrenalin and melanophore expanding hormone to assay the effect of various degrees of hypoxia at various body temperatures. Hypoxia, per se, does not

seem to effect the release of the melanophore expanding hormone. On the other hand, hypoxia as well as increasing temperature increase the adrenalin response of these animals and both factors seem to be additive. The effect of temperature on this response is roughly proportional to the metabolic rate.

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DEPARTMENT OF PHYSIOLOGY, UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE AND DENTISTRY, ROCHESTER, NEW YORK.

The Osteology of the Sacramento Perch, *Archoplites interruptus* (Girard)

CLARENCE F. DINEEN AND PAUL S. STOKELY

THE only centrarchid fish indigenous west of the Rockies is the Sacramento perch, *Archoplites interruptus*. Its native distribution is narrowly confined to the Sacramento-San Joaquin drainage and the nearby Pajaro River system. Thought to be a survivor of an ancient fauna (Miller, 1946), it has interest as possibly revealing the more generalized structural and behavioral patterns of the centrarchid stock. A study of the life history of the Sacramento perch by Murphy (1948) indicated that its reproductive behavior was more generalized than was that of the other members of the family Centrarchidae.

Reports on the osteology of the centrarchid fishes are few, scattered and incomplete. Stokely (1952) described the vertebral column of two species. Starks (1926) in his study of bones of the ethmoid region includes a crappie among a host of other fishes. Other minor references may have escaped the attention of the authors. Since the present authors are making a comparative study of the osteology of the entire family Centrarchidae, the value of beginning with a possibly more primitive species is patent. This investigation has concentrated on the osteology because the skeletal system has proved to be of great value in determining the relationship of fishes. Also, since the paleontologist has chiefly preserved skeletal remains to deal with, he frequently has difficulty in integrating his findings into a complete classificatory system; at many points his work is handicapped until he is supplied with the osteology of contemporary species. The authors hope to supply at least a segment of this much needed information for fishes.

In general the osteological terminology of Starks (1905) and Gregory (1933) has been followed (for exceptions see Stokely, 1952, Dineen and Stokely, 1954).

The present report is based upon a study of 14 specimens ranging in total length from 61 to 240 mm. Twelve specimens were furnished through the courtesy of the Department of Fish and Game, Sacramento, California. Ten of these are from a brick-yard pond near Sacramento and two from Clear Lake, Lake County, California. Likewise from Lake County are the two specimens kindly given us by Dr. Samuel Eddy from his collections at the University of Minnesota.

Eight specimens were cleared and the bones and calcified cartilage stained with alizarin sulfonate of sodium (Davis and Gore, 1936). Six were cleared and differentially stained for bone and cartilage (Williams, 1940).

A grant from the American Academy of Arts and Sciences partially supported this investigation. The authors also wish to express their thanks to Mr. Joseph F. Moran Jr. and Mr. John Winner for making the drawings. The ob-

servations and drawings were made with the aid of a binocular dissecting microscope.

With one exception, the specimens have 31 vertebrae (ultimate included): 13 in the trunk region and 18 caudals. In the single instance with 17 caudals, there is a double neural arch on the penultimate vertebra and a double haemal arch on the antepenultimate indicating a possible loss of a vertebra between these two.

All of the vertebrae, with the exception of the first two trunk, first three caudals, and those supporting the caudal fin, have centra which are quite uniform in size and shape. The centra for the first two vertebrae are shorter than those following. The first centrum is modified to form three points of articulation with the skull; a median basal one for the basioccipital and two dorso-lateral for contact with the exoccipitals (Fig. 1). This is similar to the condition found in the blue gill (*Lepomis m. macrochirus*) and the warmouth bass (*Chaenobryttus coronarius*) by Stokely (1952). Another similarity is a narrow bridge of bone which connects the terminal convexities of the centra. These are best developed on the last trunk and anterior caudal vertebrae. On the rest of the trunk vertebrae they are incorporated into the transverse processes. On the ventro-lateral area of the trunk centra, thin sheets of bone, tangential to the long axis of the centrum, form wedges between its convex ends.

Neural arches are present and complete on all vertebrae except the last two. The neural arch on the first vertebra is weakly attached to the centrum (Fig. 1). The first two neural spines interdigitate with the three "T"-shaped interneurals (Fig. 5) in the nape of the fish. The neural spines of the remaining trunk vertebrae and of the anterior caudals interdigitate with the pterygiophores supporting the dorsal fin. The neural spines ventral to the interneurals and to the spinous portion of the dorsal fin are considerably larger than the rest, which become

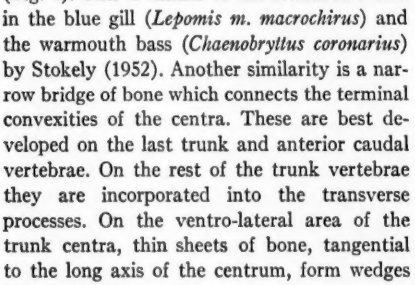

Fig. 1. First and 2nd vertebrae, (A) Anterior view of 1st vertebra; (B) Lateral view of 1st and 2nd vertebrae. C, centrum; NA, neural arch; NS, neural spine; POZ, post-zygapophysis; PRZ, prezygapophysis.

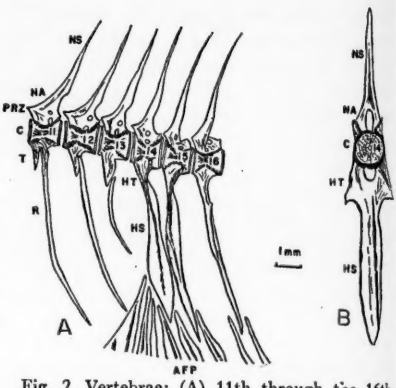

Fig. 2. Vertebrae; (A) 11th through the 16th; (B) 14th, 1st caudal (anterior view). AFP, anal fin pterygiophores; C, centrum; HT, united haemal arch and transverse process; HS, haemal spine; NA, neural arch; NS, neural spine; PRZ, prezygapophysis; R, rib; T, transverse process.

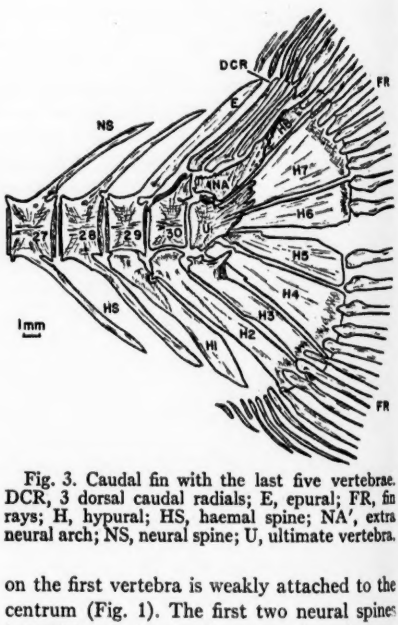

Fig. 3. Caudal fin with the last five vertebrae. DCR, 3 dorsal caudal radials; E, epural; FR, fin rays; H, hypural; HS, haemal spine; NA′, extra neural arch; NS, neural spine; U, ultimate vertebra.

progressively smaller proceeding caudad. The neural arches and spines of the caudal fin vertebrae are modified considerably.

The prezygapophyses are short spines from the neural arch directed antero-dorsad. In the trunk region they extend beyond the posterior margin of the preceding centrum (Figs. 1 and 2). The first vertebra and those supporting the caudal fin are without prezygapophyses. The second vertebra has better developed prezygapophyses than the others.

Postzygapophyses in the trunk region are better developed on the anterior vertebrae. They gradually diminish and disappear proceeding caudad. The postzygapophyses are more ventrally located on the first vertebra than on those succeeding (Fig. 1B). On the caudal vertebrae, the postzygapophyses are spine-like extensions similar to the prezygapophyses (Fig. 3, vertebra #27). Haemal zygapophyses are present as small spines on all caudal vertebrae except those supporting the caudal fin. They are best developed on the vertebrae preceding the caudal fin.

Transverse processes are lacking on the first three vertebrae. Prominent transverse processes are present on the other trunk vertebrae and the first caudal (Fig. 2). Dobbin (1941) has shown that within the Centrarchidae there is considerable variability with regard to how far the swim bladder extends posteriad. In some cases the posterior end of the swim bladder bifurcates and extends into the caudal region sometimes as far back as the sixth caudal vertebra. This is evidently a specialization and judging from our work in progress, seems to be associated with the presence of transverse processes on the anterior caudals which support the extensions of the swim bladder. In the Sacramento perch the swim bladder does not extend posteriad beyond the body cavity. In the anterior part of the vertebral column the transverse processes are located high on the centrum but proceeding caudad there is a gradual shift to a more ventro-lateral position. There is likewise a gradual increase in length and breadth from anterior to posterior.

Two categories of ribs are recognized (Hyman, 1942, p. 105): intermuscular ribs (dorsal) which are ossifications in the horizontal skeletogenous septum and pleural (ventral) ribs, always preformed in cartilage, between the coelomic wall and the hypaxial muscles. In all but one specimen pleural ribs are present on every trunk vertebrae except the first two. In the absence of pleural ribs on the first two vertebrae, intermuscular ossifications have become attached to the neural arches (epineurals). In a single specimen (on one side only) the second vertebra has a small pleural rib to which the intermuscular rib is attached instead of directly to the centrum as it is on the other side. Intermuscular ossifications (epipleurals) are present on the pleural ribs of vertebrae three to ten inclusive. They appear in the myocommata in direct alignment with the intermuscular ossifications (epineurals) on vertebrae one and two which suggest that they are of the same origin (Stokely, 1952). Pleural ribs on the third vertebra articulate with the neural arch. Proceeding caudad, however, the ribs contact the centrum adjacent to the posterior surface of the transverse process. The last two pairs of ribs articulate with the side of the transverse process itself (Fig. 2).

The first haemal arch has lateral expansions which are united to the transverse processes (Fig. 2). Its anterior surface has a large groove which receives pterygiophores from the anterior end of the anal fin. The second haemal arch and spine closely approximate the first. Both its anterior and posterior surfaces are grooved for articulation with anal fin pterygiophores. Haemal spines three to seven inclusive give indirect support to the anal fin. There is a gradual diminution in size of the haemal spines proceeding caudad. Those of the last few caudal vertebrae are modified for support of the caudal fin.

Three vertebrae are involved in the support of the caudal fin. Their centra are shorter than those of the other caudal vertebrae. On the vertebra just anterior to the antepenultimate (Fig. 3, Vertebra #28) the neural and haemal spines show a transitional stage between typical neural and haemal spines and epurals and hypurals respectively.

The antepenultimate vertebra has an elongate flattened epural with a blunt tip which supports two caudal fin rays. An elongate, blunt-tipped hypural (H1), usually ankylosed to the centrum, supports caudal fin rays and retains a haemal arch.

The penultimate vertebra has a reduced neural arch with a short, blunt spine, highly

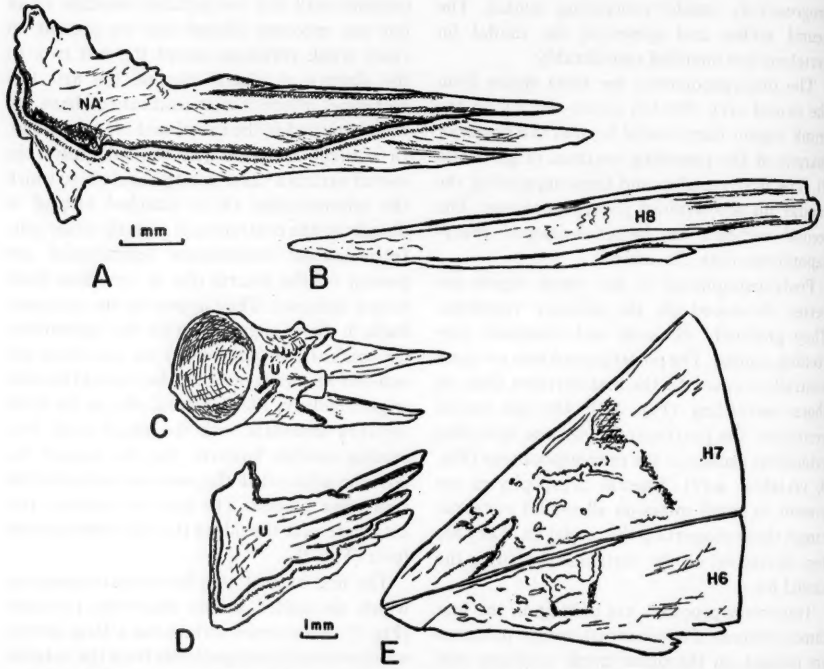

Fig. 4. Details of caudal fin. (A) Latero-ventral view of extra neural arch, NA'; (B) Hypural 8, H8; (C) Antero-dorsal view of ultimate vertebra; (D) Latero-ventral view of ultimate vertebra; (E) Hypurals 6 and 7.

variable in size and shape, which is closely associated with a dorsal caudal radial (DCR1). In one specimen these parts form a single structure, an epural. The hypural (H2) associated with the penultimate vertebra is broader than the preceding one. It is usually autogenous, has a haemal arch, supports two caudal fin rays, and has a wing-like expansion on the anterior surface of the proximal end.

The ultimate vertebra is merely the anterior half of a typical hourglass centrum which is modified posteriorly for the support of hypurals. There is no elongate urostylar process representing fused centra (Figs. 3 and 4). The two halves of its vestigial neural arch fail to meet dorsally.

Above the ultimate vertebra lies an irregular bony mass, termed an extra neural arch (NA'), probably representing the fusion of two or more neural arches and spines (Figs. 3 and 4). This structure is made up of right and left moieties joined dorsally, thus forming an inverted "V"-shaped mass. A caudal fin ray lies directly posterior to the bony mass. Two dorsal caudal radials (DCR2 and 3) are dorsal to the extra neural arch. Each supports a caudal fin ray.

The proximal end of the third hypural (Fig. 3, H3) lies ventral to the anterior end of the ultimate vertebra. It retains a haemal canal and, as in all centrarchid fishes, has a pair of bony spurs. Two fin rays are supported by this structure. Four hypurals (H4 to H7 inclusive) articulate with the terminal or ultimate vertebra (Fig. 3). Another hypural (H8) is only a splint, wedged in between the extra neural arch and hypural 7 (Figs. 3 and 4). It supports two fin rays. Hypurals 5 and 6 are about half as broad as 4 and 7. Hypurals 6, 7 and 8 are dorsal to the longitudinal axis of the body. Hypurals 4 to 7 support 12 caudal fin rays. In addition to the fin rays already mentioned, there are three (very small) anterior to the first epural and three (also small) anterior to the first hypural. The articulating surfaces of hypurals 2, 3, 4,

and 5 are of calcified cartilage. In the smaller fish, the distal ends of all hypurals are cartilaginous.

Of the 14 specimens examined all but one have 13 spines in the dorsal fin (Fig. 5). The single exception has 12. There are 12 soft rays in 12 specimens while one has 11 and another 13. Regardless of size, all spines and rays were counted. The first (very small) spine and the second are supported by the same pterygiophore. The last ray, which is very close to the preceding one, is unbranched. All of the pterygiophores lie in the septa separating the muscles between the neural spines. Inasmuch as the number of neural spines is smaller by two or three, the relationship of the pterygiophores to the neural spines is not uniformly one to one (Fig. 5). Due mainly to the development of anterior and posterior vanes, the pterygiophores articulating with the spinous portion of the dorsal fin are much heavier than the pterygiophores articulating with the rays. A pterygiophore is made up of two bony elements that ossify in a mass of cartilage (Fig. 5B). The smaller, irregularly shaped distal part lies between the bases of the spines and rays (dorsal radial of Weitzman, 1954). The elongate proximal portion interdigitates with the neural spines. In the spiny portion of the fin the distal element and the dorsal portion of the proximal form a block of bone between the ends of the spines thus limiting the extent to which each spine can be raised. In the ray portion of the fin the distal elements of the pterygiophores show a complete transition from cartilage to bone (Fig. 5B). The bases of the rays are also of cartilage.

There are usually 7 spines and 11 rays in the anal fin (one has 6 spines, three have 12 rays). All the rays are branched into two parts except

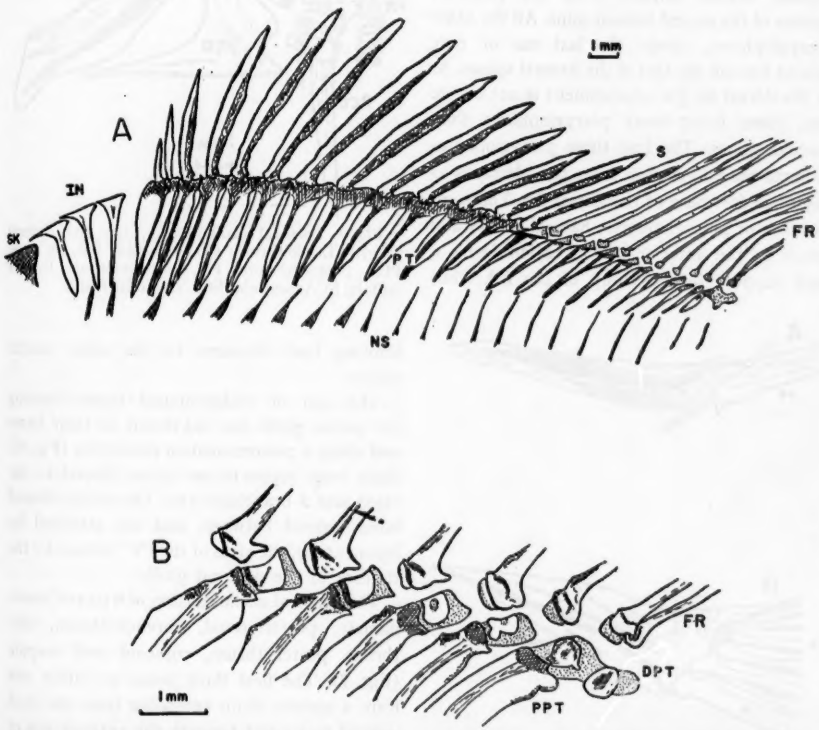

Fig. 5. Dorsal fin; (A) complete fin; (B) enlargement of posterior portion. DPT, dorsal pterygiophore; FR, fin rays; IN, interneural; NS, neural spines; PT, pterygiophore; PPT, proximal pterygiophore; S, spines; SK, skull.

the last which, like the last ray in the dorsal fin, is unbranched and lies very close to the preceding one. From 14 to 16 (usually 15) pterygiophores support the spines and rays of the anal fin. The first two pterygiophores are united to support three spines in 13 specimens and two spines in one specimen. The last two rays are supported by cartilaginous blocks representing a rudiment of a pterygiophore. In the larger specimens, each of these blocks has a tiny ossification center. As mentioned, the first two pterygiophores are united into a single element which supports the postero-ventral portion of the coelom. This element and the next three pterygiophores form a triangular mass with the proximal ends (apex of the triangle) wedged into the grooved anterior surface of the first haemal spine (Fig. 2). The sixth pterygiophore is wedged between the first and second haemal arches. The seventh pterygiophore makes contact with the posterior surface of the second haemal spine. All the other pterygiophores, except the last one or two, extend beyond the tips of the haemal spines. As in the dorsal fin the arrangement is not one to one, there being more pterygiophores than haemal spines. The last three pterygiophores indicate their formation from two elements as described for those of the dorsal fin. The combination of pterygiophores, haemal arches and spines in the anterior caudal region forms a rigid support to the trunk of the fish, thus limiting body flexures to the more caudal region.

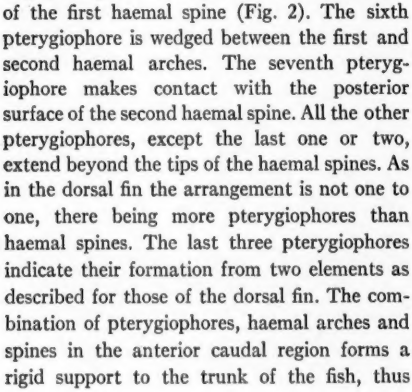

Fig. 6. Pelvic girdle and fin; (A) left half, mesial view; (B) right half, dorsal view. FR, fin rays; S, spine.

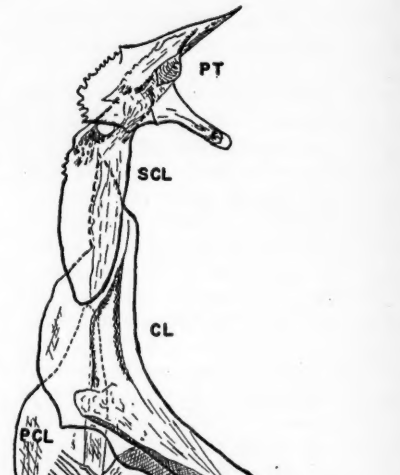

Fig. 7. Pectoral girdle and fin, right half (lateral view). CL, cleithrum; CO, coracoid; FR, fin rays; PCL postcleithrum; PT, posttemporal; RA, 4 radials; SCA, scapula; SCL supracleithrum.

The pair of wedge-shaped bones forming the pelvic girdle are ankylosed at their bases and along a postero-median projection (Fig. 6). Each bone supports one spine (lateral to the rays) and 5 branched rays. The wedge-shaped bones extend between, and are attached by ligaments to, the arms of the "V" formed by the cleithra of the pectoral girdle.

The pectoral girdle consists of 6 paired bones; namely, posttemporal, supracleithrum, cleithrum, postcleithrum, coracoid and scapula (Fig. 7). The first three bones on either side form a narrow chain extending from the skull ventral to a point beneath the anterior tips of the pelvic girdle. The posttemporal has two prongs; one is attached to the modified dorsal

surface of the epiotic and the other by a ligament to the opisthotic. The lateral surface of the posttemporal is an oval sheet of bone serrated on the postero-ventral edge. A ventral portion of the posttemporal overlaps the dorsal tip of the supracleithrum. The spatula-shaped supracleithrum articulates with the mesial surface of the posttemporal. It overlaps the dorsal portion of the cleithrum without any modifications for articulation. There are a few serrations on the posterior edge of the supracleithrum. The long, broad dorsal end of the cleithrum terminates in a spine. The narrow ventral extension curves anteriad and joins its partner on the opposite side by a short ligament.

The spindle-shaped postcleithrum extends from a mesial surface of the upper portion of the cleithrum to a point ventral to the pectoral fin. The dorsal end has a large vane on its posterior surface (Fig. 7).

The rectangular, dorsal portion of the coracoid is sometimes overlapped slightly by the cleithrum. The coracoid joins the scapula by connective tissue which does not take the stain for cartilage. The elongate, ventral portion terminates posteriorly in a spine and extends anteriad to meet the ventral end of the cleithrum.

The anterior dorsal portion of the scapula is overlapped by the cleithrum. There is a large foramen in the center and the posterior surface serves as an articulating area for three radials and one fin ray.

Four hour-glass radials support each pectoral fin (Fig. 7). The fourth radial (most dorsal) is much shorter than the others and nearly as broad as long. The first radial articulates with the connective tissue between the coracoid and scapula. The second radial articulates in part with this same area and in part with the scapula; the third and fourth articulate with the scapula.

Eleven specimens have 14 pectoral fin rays; three have 15. On the ventral edge of the pectoral fin there are two or three unbranched rays. Proceeding dorsad there are 11 branched and finally one unbranched ray. This unbranched (most dorsal) fin ray has an enlarged proximal end which articulates directly with the scapula. The ends of the radials and the articulating surface of the scapula and coracoid are cartilaginous.

Viewed from above the most conspicuous bones of the skull are the frontals, which cover most of the dorsal surface (Fig. 8). (Unless stated otherwise, all skull bones are paired.) Posteriorly the frontals articulate with the parietals and the medial supraoccipital. Posterolaterally they unite with the sphenotics. A keel arises from the dorsal surface of each frontal and is in alignment with a similar keel on the respective parietal (separate ossifications in a common membrane). Anteriorly the frontals overlap the unpaired mesethmoid and the prefrontals. The sensory canals are discussed later.

Each parietal is bounded by a frontal, the

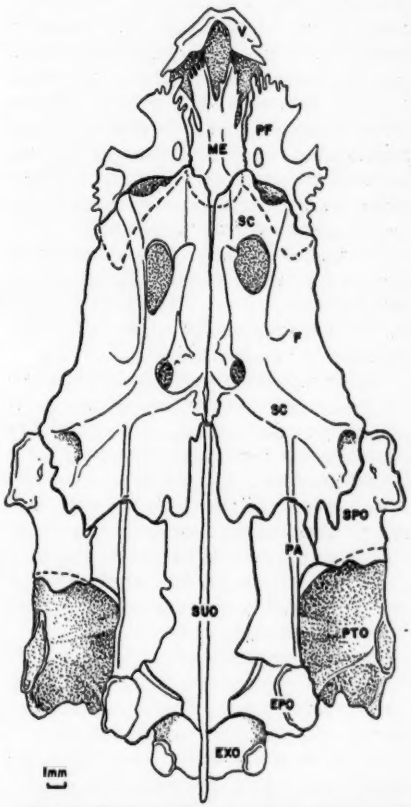

Fig. 8. Skull of 160 mm. Sacramento perch (dorsal view, sensory canals removed except on frontals). EPO, epiotic; EXO, exoccipital; F, frontal; ME, mesethmoid; PA, parietal; PF, prefrontal; PTO, pterotic; SPO, sphenotic; SUO, supraoccipital; V, vomer.

supraoccipital, an epiotic (Fig. 8). The parietals are separated by the median supraoccipital.

The prefrontals are irregularly shaped bones with posterior projections extending under the frontals. The posterior surface of each prefrontal forms the anterior orbit of the eye (Fig. 10). The two bones are not in contact medially but are separated by cartilage on the ventral side and by the mesethmoid dorsally (Fig. 8). A ventral process fans out toward, and in larger specimens contacts, the parasphenoid. In older fish an anterior extension meets the vomer.

The unpaired mesethmoid is a triangular cap of bone which extends from beneath the anterior edge of the frontals and separates the prefrontals (Figs. 8 and 10). The front of the triangle slopes anteroventrad toward the vomer. However, a cartilaginous rostral keel connects the mesethmoid with the vomer. Small ossifications (the number of which increases with size of fish) embrace the mesethmoid-vomerine keel forming a bony fringe around the antero-ventral border of the mesethmoid. In larger fish these fringe elements broaden and elongate—the median ones contacting the vomer.

The preorbitals (lachrymals) are triangular bones bearing a sensory canal. Each articulates with a prefrontal and is serrated on its ventral edge. Other circumorbital bones are portions of sensory canals discussed later.

The parasphenoid is an unpaired bone extending from the nasal cartilage to the posterior extremity of the basioccipital (Fig. 9). The elongate anterior end supports the roof of the mouth. The vomer is attached to the ventral side of the anterior tip. Lateral processes contact the antero-mesial portions of the prootics. The elliptical posterior portion of the parasphenoid is attached to the ventral surface of the basioccipital, giving considerable support to the occipital condyle.

The basisphenoid is a small, unpaired, "Y"-shaped bone with each fork of the "Y" contacting a prootic dorsally. The base of the "Y" extends antero-ventrad toward, but does not meet, the parasphenoid (Fig. 10). The structure is as described by Parker and Haswell (1951: 242) forming the anterior end of the basis cranii.

The unpaired vomer is a circular bone with a process extending caudad (Fig. 9). The process lies in a ventral groove on the anterior end of the parasphenoid. The vomer forms a partial cap over the anterior end of the nasal cartilage. A lunate mass of bone bearing teeth extends ventrad from the anterior end of the vomer.

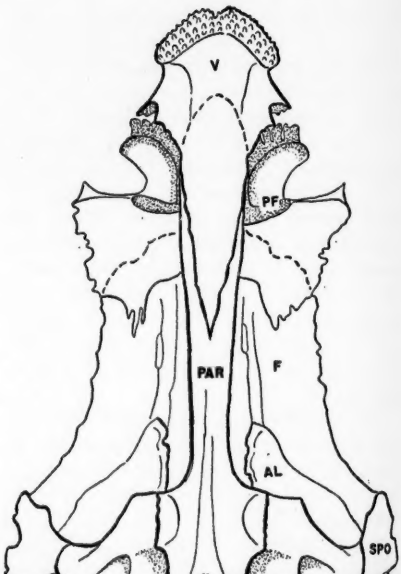

Fig. 9. Skull of 160 mm. Sacramento perch (ventral view). AL alisphenoid; BAO, basioccipital; EXO, exoccipital; F, frontal; OPO, opisthotic; PAR, parasphenoid; PF, prefrontal; PRO, prootic; PTO, pterotic; SPO, sphenotic; V, vomer.

The alisphenoid forms a ventral keel on the frontal and contributes to the posterior border of the orbit (Figs. 9 and 10). It contacts the sphenotic and is united with the prootic by a narrow bridge of bone but does not contact its partner from the other side.

The unpaired basioccipital is fan-shaped.

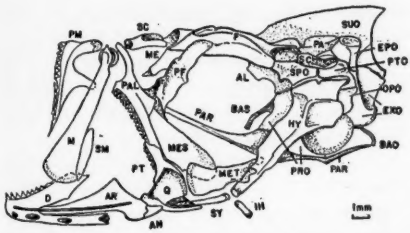

Fig. 10. Skull of 78 mm. Sacramento perch (lateral view, preorbital and opercular bones removed). AL, alisphenoid, AN, angular; AR, articular; BAO, basioccipital; BAS, basisphenoid; D, dentary; EPO, epiotic; EXO, exoccipital; F, frontal; HY, hyomandibular; IH, interhyal; M, maxillary; ME, mesethmoid; MES, mesopterygoid; MET, metapterygoid; PAL, palatine; PAR, parasphenoid; PF, prefrontal; PM, premaxillary; PT, pterygoid; PTO, pterotic; Q, quadrate; SC, sensory canal; SM, supramaxillary; SPO, sphenotic; SUO, supraoccipital; SY, symplectic.

Its posterior end is modified to form a condylar articulation with the first vertebra (Fig. 9). The ventral surface of the basioccipital is grooved to receive the posterior end of the parasphenoid to which it is attached. The postero-lateral surfaces are directed dorsad and joined to the exoccipitals. The basioccipital forms the postero-ventral portion of the otic capsules.

The exoccipital is bounded by the basioccipital, prootic, opisthotic, pterotic, epiotic and supraoccipital (Figs. 8, 9 and 10). The posterior surface of each exoccipital forms a condyle for articulation with the first vertebra. Dorsal wings from each unite above the foramen magnum forming an arch over the nerve cord. From the point of union there extends dorsal a single thin sheet of bone which unites with the median dorsal wing on the supraoccipital (Fig. 10).

The supraoccipital is an unpaired bone forming a large part of the posterior portion of the dorsal surface of the cranium (Fig. 8). Posteriorly it unites with the exoccipitals, laterally with the epiotics and parietals and anteriorly with the frontals. A large medial keel extends the full length of the supraoccipital (Figs. 8 and 10) and unites with a keel formed from the exoccipitals.

Of the five bones comprising the otic series on each side, the prootic is the largest (Fig. 9). It is an irregularly shaped bone. The pair cover a large area of the ventral surface of the cranium and form a portion of the otic capsules. Each is bounded by the alisphenoid, sphenotic, pterotic, opisthotic, parasphenoid and basisphenoid. Medial wings on the prootics join similar lateral wings from the parasphenoid.

The sphenotic is bounded on the dorso-mesial surface by the frontal thus forming the postero-dorsal limits of the orbit (Fig. 10). A postero-mesial process of the sphenotic is bounded by the frontal and parietal (Fig. 8). Posteriorly the sphenotic contacts the pterotic (Fig. 10). On the ventro-mesial surface it is bounded by the alisphenoid and prootic.

The pterotic forms the postero-lateral corner of the cranium (Figs. 8, 9 and 10). It is bounded by the sphenotic, prootic, opisthotic and exoccipital. The pterotic lies lateral and ventral to the epiotic and parietal.

The opisthotic is a flat bone (Fig. 9) wedged among the exoccipital, pterotic and prootic.

The epiotic is a cone forming a postero-dorsal corner of the cranium (Fig. 8). Each is bounded anteriorly by a parietal and the supraoccipital; mesially by the supraoccipital; ventrally by the exoccipital. The dorsal surface is modified for the attachment of a post-temporal.

The palatine is a narrow curved bone bearing teeth along its anteroventral border (Fig. 10). The dorsal end articulates with the large notch of the maxillary and connects with the prefrontal by a ligament. Ventrally the palatine joins the pterygoid and mesopterygoid.

The pterygoid bone is boot-shaped (Fig. 10). The "sole" of the boot joins the anterior surface of the quadrate. The "leg" overlaps the palatine and bears a few teeth. The mesopterygoid joins the posterior margin of the pterygoid. A process, "heel of the boot", on the pterygoid extends caudad between the mesopterygoid and the quadrate.

The mesopterygoids are thin sheets of bone joined mesially by a membrane thus forming the roof of the mouth (Fig. 10). Each is bound by the respective palatine, pterygoid, quadrate, and metapterygoid. Each mesopterygoid bears a small patch of teeth.

The metapterygoid is a thin bone bounded by the mesopterygoid, quadrate, symplectic and the hyomandibular (Fig. 10). A process extends dorsad joining the hyomandibular. A narrow sheet of bone extends from the lateral

surface of the metapterygoid and contacts the lateral surface of the ventral arm of the hyomandibular.

The anterior end (dorsal in open mouth, Fig. 10) of the maxillary is twisted to form articulating surfaces which receive the premaxillary and the palatine. The greatest width of the paddle-shaped, posterior end (ventral in open mouth) is about one-third the total length of the bone. When the mouth is closed, the posterior margin of the maxillary is ventral to the most anterior ossification of the suborbital sensory canal.

The supramaxillary, dorsal (posterior in open mouth, Fig. 10) to the posterior end of the maxillary, is about one and one-half times as long as the greatest width of the latter bone.

The premaxillary forms the antero-lateral border of the upper jaw (Fig. 10). Its dorsal margin is modified to receive the antero-ventral portion of the maxillary when the mouth is closed. A medial process from the premaxillary extends dorso-caudad to meet the rostral cartilage. Except for the lateral tips, the entire length of the ventral margin bears teeth.

The "V"-shaped dentary joins the articular posteriorly. It bears teeth on the anterior three-fourths of the dorsal surface (Fig. 10). A core of cartilage (Meckel's) extends along the axis of the dentary and the articular. The two dentaries are joined mesially.

The anterior end of the wedge-shaped articular is attached to the ventral arm of the dentary (Fig. 10). The posterior portion of the articular is heavily ossified and forms the articulating surface for the quadrate. A small sesamoid articular (Starks, 1916) is fused to the mesial surface of each articular.

The angular is a small triangular bone attached to the mesial surface of the postero-ventral corner of the articular, ventral to the condyle (Fig. 10).

The quadrate bone functions as the keystone at the junction of the pterygoid, upper hyoid bones and lower jaw series of bones (Fig. 10). The antero-ventral corner is greatly thickened, forming the articulating surface for the articular. A large spine extending caudad from the condylar region is modified on its ventral surface to receive the preopercular. A groove on the mesial surface of the quadrate, dorsal to the spine, receives the symplectic.

The symplectic is an elongate cone which extends from the hyomandibular to the quadrate (Fig. 10). The narrower anterior end fits into the mesial groove of the quadrate. The posterior end joins the block of cartilage which lies between the ventral arm of the hyomandibular and interhyal.

The head of the hyomandibular joins the articulating surface formed by the sphenotic, pterotic and prootic bones (Fig. 9). A short, thick posterior process affords an articulating surface for the opercular. As already noted, a ventral arm joins the cartilaginous block contacted also by the symplectic and interhyal (Fig. 10). The relation to the metapterygoid has been given above. A lateral wing from the hyomandibular contacts the anterior surface of the dorsal arm of the preopercular.

Four bones compose the opercular series. The opercular is a triangular bone articulating with the hyomandibular. Its posterior corner is serrated. The subopercular is an elliptical bone which is slightly overlapped by the opercular and the interopercular. The free edge is partially serrated. The interopercular is likewise elliptical with its dorsal half covered by the preopercular. The posterior portion of its ventral margin is serrated. The preopercular is an "L"-shaped bone with the dorsal arm articulating with the hyomandibular and the ventral arm with the spine of the quadrate. There are serrations on the ventral and posterior edges.

Imbedded in the sclera of each eyeball are two saucer-like ossifications, sclerotic plates. One is on the anterior, the other on the posterior surfaces of the eyeball.

A well developed system of sensory canals extends over dorsal and lateral surfaces of the head (Figs. 8 and 10). A pair of short sensory canals with terminal openings lies dorsal to the cartilaginous portion of the nasal capsule. They are continuations of canals on the frontal bones. These latter extend along the median portion of the frontals as far as the anterior end of the keel on the supraoccipital. From this point each angles laterad and extends to the point where the frontal and sphenotic unite. In addition to the terminal openings there is one at the bend, opening medially, and one half-way between the bend and the anterior terminus. The suborbital sensory canal contains six separate ossifications connecting the posterior end of the sensory canal on the frontal with the sensory canal on the preorbital. In small fish these ossifications

are for the most part open channels rather than completely enclosed canals. The sensory canal on the preorbital (lachrymal) extends the length of the bone and has four openings, two terminal and two on the ventral surface.

A short sensory canal extends from the sphenotic to the pterotic (Fig. 10). On the flesh between the epiotic and pterotic is a "Y"-shaped sensory canal with terminal openings. One arm communicates with the sensory canal from the pterotic to the sphenotic; the posterior arm communicates with the sensory canal on the posttemporal; the dorsal arm communicates with a short sensory canal on the flesh. The sensory canal on the posttemporal extends the full length of the bone. In addition to its terminal openings, there is an opening on the dorsal side. A short canal on the dorsal end of the supracleithrum connects the lateral line with the sensory canal on the posttemporal (Fig. 7).

A sensory canal extends the full length of the preopercular. It bears five openings anteriorly in addition to the terminal ones. The dentary is traversed by a sensory canal with three openings in addition to the terminals. The sensory canal on the articular forms a connecting link between the sensory canals on the dentary and preopercular.

In the hyoid arch (Figs. 11 and 12) each interhyal is a small rod of bone connecting the postero-dorsal margin of the epihyal to the cartilaginous block between the symplectic and the hyomandibular (Figs. 10 and 11). In the smaller specimens the structure is largely cartilage.

The epihyal is a triangular bone between the interhyal and the ceratohyal. Both the epihyal and the ceratohyal have bony processes from their mesial surfaces which interdigitate, thus forming a firm bridge between the two bones.

The anterior end of the hour-glass ceratohyal is considerably smaller than the posterior and articulates with the two parts of the hypohyal.

The hypohyal is a double bone. Each part is cone-shaped with the bases of the cones joined by connective tissue and a small bridge of bone (Fig. 11). The dorsal cone is divided into two complete halves by an infolding of the cone. It articulates with a notch on the ceratohyal, and the ventral cone is modified to receive a projection from the antero-ventral corner of the ceratohyal.

The unpaired basihyal is rod-shaped. The posterior end joins the apexes of the dorsal parts of the hypophyals. Two plates of teeth on the postero-dorsal surface are separated along the midline by a groove (Fig. 12).

The three unpaired basibranchials lie in the midventral line of the pharynx (Fig. 12). The first (anterior) basibranchial is a curved rod of bone lying between the hypohyals and extending anteriad beneath the basihyal. The second basibranchial is hour-glass shaped. The anterior

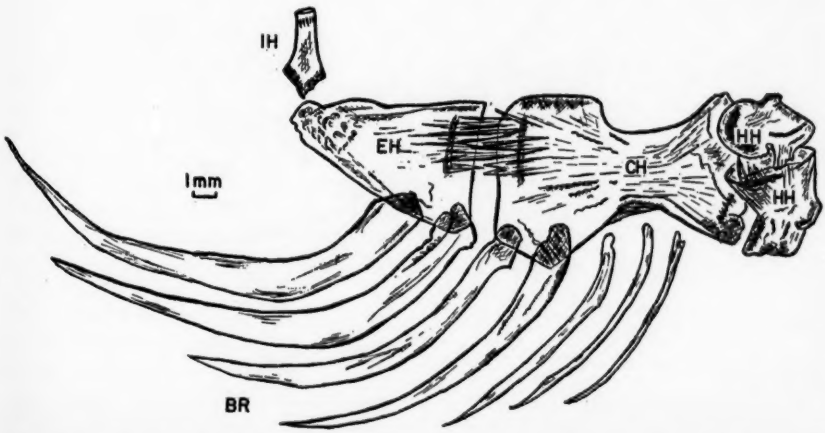

Fig. 11. Hyoid arch, left half (mesial view). BR, branchiostegals; CH, ceratohyal; EH, epihyal; HH, hypohyal; IH, interhyal.

end is about one-half as broad as the posterior and is curved slightly ventrad. The third basibranchial is a longer bone than the second. It bears a large plate of teeth on the dorsal surface.

The anterior end of the first hypobranchial is curved mesad and articulates with the constricted lateral side of the second basibranchial. The second hypobranchial, shorter than the first, has a greatly enlarged anterior end which articulates with a notch on the antero-lateral surface of the third basibranchial. The third hypobranchial is an elongate cone

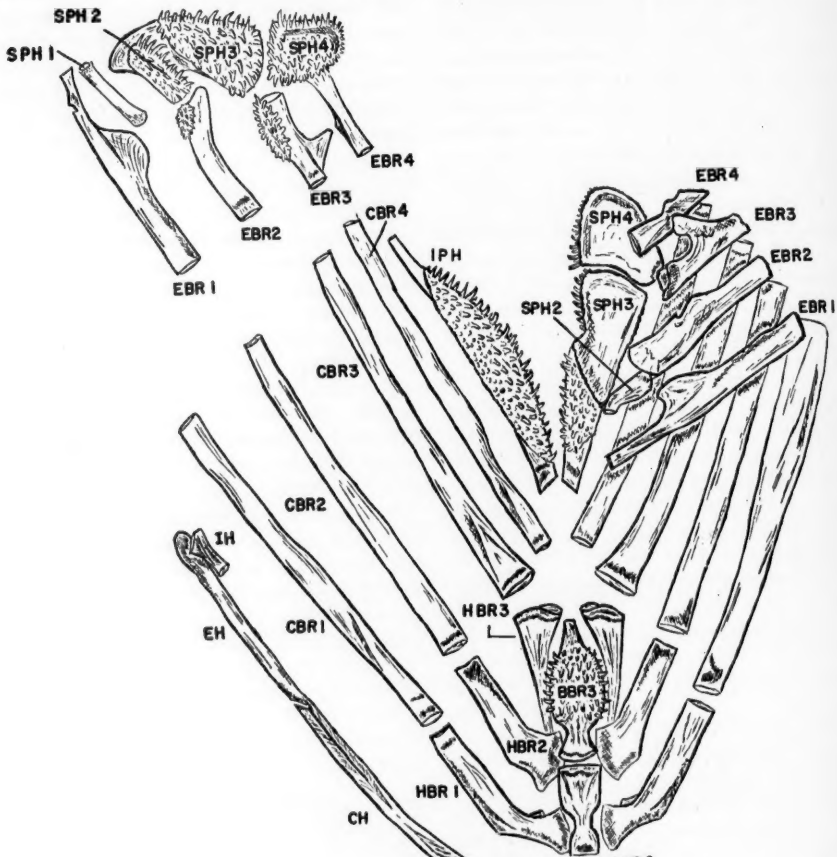

Fig. 12. Hyobranchial system, dorsal view (except upper portion of the right arches—ventral view). BBR, basibranchial; BH, basihyal; CBR, ceratobranchial; CH, ceratohyal; EBR, epibranchial; EH, epihyal; HBR, hypobranchial; HH, hypohyal; IH, interhyal; IPH, infrapharyngeal; SPH, suprapharyngeal.

adjacent to the third basibranchial but with its long axis inclined dorso-ventrad (Fig. 12). The basal portion of the cone forms a part of the floor of the pharynx. The apical end is attached by ligaments to the basibranchiostegal.

The four slender, rod-like ceratobranchials are very similar (Fig. 12). The anterior end of the third is wider than the others. Together with the three hypobranchials, they form the ventral halves of the branchial arches.

There is a gradual decrease in length of the rod-shaped epibranchials from first to third. The third and fourth are of about equal length (Fig. 12). The second bears a small patch of teeth near the end adjacent to the second suprapharyngeal. The third epibranchial bears a considerably larger patch of teeth. There are dorsal processes on each of the epibranchials; those on the third and fourth meet.

The suprapharyngeal of the first branchial arch is a rod-shaped bone directed posterodorsad (Fig. 12) and connects the epibranchial of that arch with the prootic. The remaining suprapharyngeal bones are modified structures with large plates of teeth covering the ventral surface (Fig. 12).

A single bone (infrapharyngeal, Chapman, 1934) represents the fifth branchial arch on each side. The dorsal surface is almost entirely covered with a mass of teeth. The anterior ends of the two bones closely approximate each other (Fig. 12).

Two rows of gill rakers are present on each of the four branchial arches. Those making up the anterior row on the first branchial arch are much longer than the rest and are attached to the arch by forked (two or three pronged) ends. The rakers on the other arches are attached to the lateral sides of the arch by a concave surface. The rakers are smaller and fewer in number on the last arch.

The branchiostegal membrane on each side is supported by seven branchiostegals; two attached to the epihyal and five to the ceratohyal (Fig. 11). From anterior to posterior the branchiostegals increase in size.

The unpaired basibranchiostegal (terminology of Parker and Haswell, 1951) is a long compressed bone (Fig. 13) imbedded in the muscles of the isthmus. It is attached by ligaments to the hypohyals and to the anteroventral extensions of the third hypobranchials.

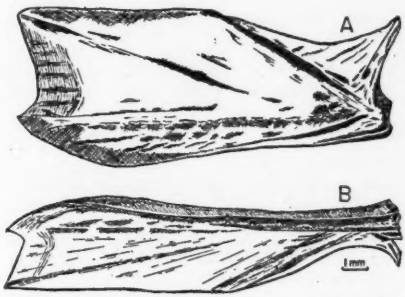

Fig. 13. Basibranchiostegal;(A) lateral view, (B) lateroventral view.

The paucity of osteological information on the centrarchids necessitated a complete description of one species. Whether the Sacramento perch was the wisest choice remains to be seen. Indications of primitive conditions in the Sacramento perch can only be determined with certainty as the comparative osteological study, based on statistical analyses, progresses. Upon completion, it is planned to depict the relationship of all members of the family Centrarchidae based upon osteological comparisons. How well this will match current phylogenies within the Centrarchidae based largely upon external features and how well it can be correlated with the ecology of the species remains to be determined.

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DEPARTMENT OF BIOLOGY, THE UNIVERSITY OF NOTRE DAME, NOTRE DAME, INDIANA.

Adjustment of Water Loss in Response to Desiccation in Amphibians

THOMAS B. THORSON

THE transition of any group of animals from the aquatic to the terrestrial way of life of necessity requires basic changes in the handling of body water. These changes may involve the nature or rate of uptake and excretion of water, the rate of water loss by evaporation from the body surface, storage of water, tolerance to water loss, and water conserving behavior.

Amphibians in general have been relatively unsuccessful in the transition to terrestrial life, apparently not having made the requisite changes in body water control in great enough degree. Nevertheless they are a transitional group from a historical point of view as well as from the standpoint of life history, and so are particularly well suited to studies of the factors involved in the development of terrestrial habits.

Three features of water economy have recently been discussed as to their possible role in the development of terrestrial habits among amphibians; (1) the resistance of the skin to water loss, (2) the rate of water uptake following desiccation, and (3) the degree of tolerance to water loss (Thorson, 1955).

The present study considers the possibility of a fourth characteristic, which, if present, could conceivably be of adaptive value to these animals in a dry environment. If an amphibian species had, as an immediate response to dehydration, the capability of reducing water loss, or, if desiccation produced a sustained inhibiting effect on subsequent evaporation, it would appear that this species would be aided in the occupation of a land habitat. Apparently the possibility of this type of regulation of water loss has been overlooked by those who have studied amphibian water economy.

Certain features of body water control of amphibians in the water (i.e., functioning as aquatic animals) have been altered experimentally. For example, the injection of an extract from the posterior lobe of the pituitary gland, or certain fractions thereof, into amphibians is well known to produce an increase in their water content. This change probably takes place by means of an increased uptake of water through the skin and an anti-diuretic action on the kidneys. The rate of transport of water through the skin has also been altered by various substances of a toxic, narcotic, or anaesthetic nature, which almost always increase the permeability of the skin to water.

That an amphibian in water can carry out adjustments of water content without experimental manipulation by the investigator is apparent from the data in Table I. Six frogs (*Rana pipiens*) weighed daily varied appreciably in weight. They were kept under essentially constant conditions of temperature, light, and osmotic pressure of the medium,

were not fed, and, following the forcible emptying of the bladder, were weighed at the same time every day. By weighing the same frog at five-minute intervals for an hour, it was determined that errors in weighing were not responsible for the variations. The frog was returned to water after each weighing and was re-dried before being weighed again. The difference between any two consecutive weighings did not exceed 0.02 gram. A slight increase in weight during the hour was undoubtedly due to absorption of water through the skin and accumulation of urine in the bladder. Urine was forcibly expelled from the bladder before the first weighing but not before each subsequent weighing.

Abnormal changes in water control of frogs in water is also evident in the frequent occurrence of edema before death of diseased frogs and the less frequent appearance of the opposite condition, physiological dehydration.

The present investigation is concerned with the adjustment of the rate of outward transport of water in response to exposure to drying conditions in the atmosphere. Regarding this phase of amphibian water economy, comparatively little is known.

At least two authors have reported experimental alteration of the rate of water loss in frogs in air. Angerer and Angerer (1949), by adrenalectomy, brought about a reduction in the rate of water loss through the skin of *Rana pipiens*, and Boyd and Whyte (1938), using injections of posterior pituitary extract, claimed a similar, although less pronounced, water conserving action in the same species.

From these experimental alterations of the rate of water loss, it might be inferred that the amphibian itself may, under the influence of the proper stimulus, adjust its rate of water loss. Jørgensen (1950) proposed that frogs when desiccated may increase the production of posterior pituitary hormones and thus change the permeability of the skin and increase the rate of uptake following loss of water. However, this was speculation and concerned only inward passage of water through the skin. Direct experimental evidence for any intrinsic adjustment of water loss as a result of desiccation is lacking in the literature.

The experiments reported below were designed to answer two questions: (1) Do amphibians make an immediate adjustment to loss of water by changing the rate of loss through the skin while desiccation is in progress; and, (2) do they exhibit a sustained adaptation to desiccation whereby the skin acquires greater resistance to drying after they have undergone a period of desiccation?

TABLE I

DAILY VARIATION IN WEIGHT OF *Rana pipiens* (in grams)

Days	Frog number					
	1	2	3	4	5	6
Starting weight	16.5	17.1	20.1	16.3	22.0	23.0
1	16.8	17.1	20.3	15.8	21.5	22.6
2	17.1	17.3	20.1	17.0	21.4	22.4
3	16.7	17.1	19.7	16.5	21.7	22.7
4	16.2	17.0	20.3	17.1	21.5	23.2
5	16.4	16.6	19.6	16.3	22.5	23.4
6	15.7	17.3	19.6	16.6	21.9	22.9

IMMEDIATE ADJUSTMENT TO DESICCATION

At least four investigators appear to have provided negative answers to the first question. Overton (1904) observed that loss of water from the salamander, *Triton cristatus*, proceeded at nearly the same rate up to a loss of about 25 percent of the body weight as long as the temperature and relative humidity remained the same. Hall (1922), experimenting with another salamander, *Ambystoma punctatum*, found that the loss of water took place at a constant rate until at least 40 percent of the weight had been lost. Rey (1937) also stated that the speed of evaporation remained constant if the water loss was not too rapid. He did not, however, present any supporting data. Littleford et al. (1947), citing as examples two species of salamanders, *Desmognathus fuscus* and *Pseudotriton ruber*, found that the loss of water proceeded at a relatively constant rate and concluded that these salamanders possessed no mechanism for retarding the rate of water loss.

In the three investigations above in which data were presented to support the conclusions, weighings were not made often enough to provide an accurate record of the rate of water loss. Indeed, in the two papers which gave figures (Overton and Littleford *et al.*), appreciable differences in the rates are evident.

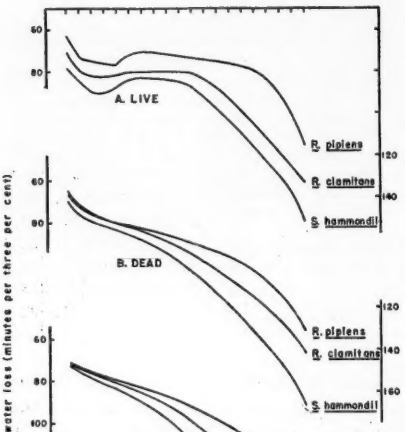

Fig. 1. Living, dead, and skinned dead frogs of three species compared as to changes in rate of water loss in the course of desiccation to a loss of sixty percent of the original weight. Abscissas represent twenty successive periods of three percent weight loss. Ordinates express the number of minutes that elapsed during each of these periods. Each curve represents an average derived from the desiccation of sixteen animals.

In the present study experiments were designed to trace in a more exact manner the rate of water loss during the course of desiccation, with the purpose of detecting any adjustment in rate that might take place. Four animals were desiccated at one time in separate compartments of a wire cage suspended in a desiccation chamber from the beam of a scale. By correcting for the weight of the cage, the weights of the experimental animals could be read directly at the desired intervals. Air previously dried by sulfuric acid was passed through the desiccating chamber from a system like that described by Thorson and Svihla (1943). Air flow was adjusted to four liters per minute through a jar of six liters capacity. The desiccating chamber, cage, and scale were placed in a constant temperature incubator at 25°C. The frogs were desiccated to a loss of 60 percent of their original body weight. Readings were taken of elapsed time at the end of each 3 percent of weight lost. This procedure continued until 20 readings had been taken and only 40 percent of the original weight remained. Invariably all animals were dead before this point was reached.

Three species were used: *Rana pipiens* and *R. clamitans*, both obtained from Wisconsin suppliers, and *Scaphiopus hammondi*, collected during the month of May from breeding ponds near Vantage, Washington. Three series of experiments were performed: (1) A series of 16 living frogs of each species, averaging 20 grams in weight, was first desiccated as described. (2) The same treatment was given to the same number of equal-sized ether-killed specimens of each of the same species. (3) A third series was desiccated using skinned, ether-killed animals, whose skinless weight averaged 20 grams.

The results of these experiments are shown in Figure 1. It is obvious that the living frogs did not lose water at a constant rate throughout the course of desiccation. The changes in rate followed a basically similar pattern in all three species. The initial rate, relatively high, decreased during the first 4 or 5 periods (a 12 to 15 percent weight loss), then increased more or less sharply during the next 2 to 4 periods, slowed again for a period of time which varied in the three species, and finally decreased rather sharply until the loss of 60 percent of the initial weight was reached (the end of the twentieth period).

To determine which characteristics of these curves resulted from internal adjustments, it is necessary to make a comparison between the curves for living animals and those for dead ones. In the latter, no physiological adjustment of water loss was possible. They lost water passively, at a rate determined strictly by the physical factors involved in the experimental procedure. Figure 1, B, indicates that the dead animals lost water at a decreasing rate throughout the 20 periods. The living animals on the other hand (Fig. 1, A) underwent two reversals in rate of water loss, which must therefore have been brought about by physiological adjustments of the animals themselves, since experimental conditions

were the same as those used with the dead animals.

It was impossible to determine the nature of the adjustment that took place from the data obtained and therefore a conclusive interpretation is impossible. However, there are several possible explanations, some or all of which may apply:

1. During most of the period of desiccation the living animals lost water at an appreciably more rapid rate than the dead ones. A logical conclusion might be that the circulatory system brought water from deeper tissues to replace the water lost by evaporation through the surface membranes, whereas in the dead animals diffusion from the deeper tissues alone must have replaced the surface water. However, it is impossible to explain the early decrease in rate of water loss of live animals on this basis, for in *Rana clamitans* and *Scaphiopus hammondi* the living animals lost water more slowly than the dead ones for a few hours. Furthermore, Rey (1937) found that frogs (*R. esculenta*) deprived of cutaneous circulation lost water at the same rate as those whose circulation was intact.

2. Overton (1904) recognized that the degree of activity of amphibians during desiccation affected the rate at which water was lost. The frogs used in the present experiments were desiccated in an incubator where they could not see movements on the outside which might agitate them. Thus shielded from disturbing movements, they were not observed from the outside except when the door was opened to take scale readings. During the period of acceleration of water loss, no increased activity was detected during the intervals of weighing. It is therefore believed that increased activity of the animals probably was not responsible for the long period of rapid loss. The degree of activity could not explain the earlier period of water loss which was slower in live than in dead animals in *R. clamitans* and *S. hammondi*.

3. A third possibility is that after a loss of 12 to 15 percent, an increased secretion of mucus occurred, thus enabling a more rapid loss of water to take place. Under various adverse conditions including desiccation, some amphibians, especially salamanders, may secrete an appreciable quantity of mucus from the skin. No such phenomenon was observed in any of the present species. It was noted in other experiments that the skin remained moist even when desiccation was well advanced (up to about 30 or 35 percent loss), but mucus was not in evidence. Here again, mucus secretion could not account for the peculiarity of the first portion of the curves for living animals.

4. There remains the possibility that an adjustment of the permeability of the skin to water may have been responsible for the changes in rate and although the first three possibilities cannot be ruled out completely, this appears to be the best explanation, particularly in light of findings to be reported on later.

Regardless of the mechanism responsible for the observed changes in the rate of water loss, a consideration of the possible significance of the phenomenon is in order. The question of whether or not amphibians can make an immediate adjustment to desiccation has been answered in the affirmative. However, whether this adjustment has any survival value in a terrestrial habitat is questionable. The only phase of the adjustment which can be considered a mechanism for water conservation is shown by the early part of the curves for live *R. clamitans* and *S. hammondi*. Here for a short time, there appears to be a force at work which inhibits loss of water. Later, however, the trend is in the direction of water dissipation rather than conservation. Thus, the changes in rate of desiccation can hardly be considered of adaptive value to these amphibians on land.

The three series of skinned animals were desiccated to determine if there was any difference in the resistance to water loss between the skin and the underlying tissues. In all three species (Fig. 2), water loss in the dead but intact amphibians and the skinless ones took place at nearly the same rate during the early stages of desiccation, but later the skinned amphibians lost water more slowly. That the rates in the early stages were almost identical might be interpreted as showing that the permeability of the skin is nearly the same as that of the deeper tissues, and that in any case, the skin provides little if any protection from water loss. The slower rates

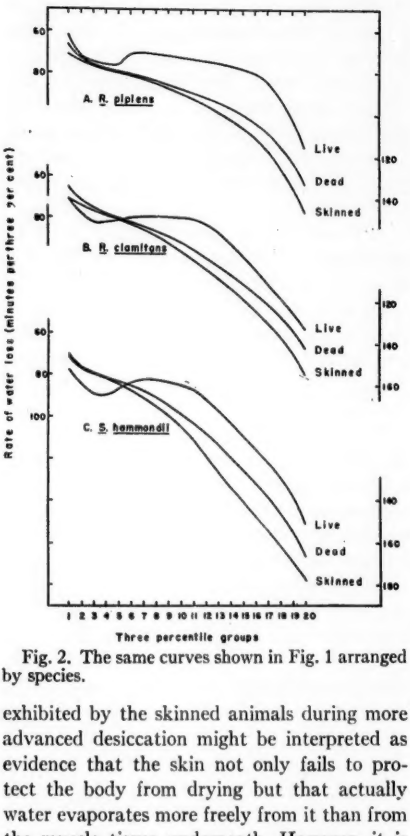

Fig. 2. The same curves shown in Fig. 1 arranged by species.

exhibited by the skinned animals during more advanced desiccation might be interpreted as evidence that the skin not only fails to protect the body from drying but that actually water evaporates more freely from it than from the muscle tissue underneath. However, it is more probable that the skinning of the animals is equivalent to a slight initial dehydration. Rey (1937) found that in *Rana esculenta* whose body water content was 80.5 percent of the total weight, the skin had a slightly lower water content (77.0 percent), but that of the blood was very high (88.0 percent). Presumably lymph, containing less solid matter, has an even higher water content than blood. Frogs (*Rana pipiens* and *R. clamitans*) whose skinless weight averaged about 20 grams lost an average of about 17.5 percent of their initial weight in the skinning process (Table II). About 60 percent of this loss represented skin while the remainder was mostly lymph, but included a little blood. The skin and lymph removed before desiccation began contained a greater percentage of water than the intact frog, whereas the parts remaining

TABLE II
WEIGHT LOSS OF FROGS THROUGH SKINNING
(in grams)

	R. pipiens (Average of four)	*R. clamitans* (Average of four)
Original weight	24.63	24.46
Weight skinned	20.08	20.42
Loss	4.55 (18.4%)	4.04 (16.5%)
Weight of skin	2.66	2.47
Weight of blood and lymph	1.89	1.57

TABLE III
AVERAGE TIME REQUIRED TO LOSE SIXTY PERCENT OF BODY WEIGHT
(hours and minutes)

	Live	Dead	Skinned
R. pipiens	26:08	30:19	31:54
R. clamitans	30:27	32:12	34:24
S. hammondi	33:41	35:52	38:27

to be desiccated included the skeleton and contained somewhat less than the overall percentage of water of an unskinned animal. The rate of water loss therefore might be expected to be slower than that in the dead but intact animals, at least after the early stages of desiccation.

The average time required to reach a loss of 60 percent of the body weight for each of the nine series of experimental animals in Figures 1 and 2 is recorded in Table III. These figures confirm the findings of an earlier investigation (Thorson, 1955) that, of these three species, *R. pipiens* loses water most rapidly and *S. hammondi* most slowly, whereas *R. clamitans* is intermediate. This is true not only of the living animals but of the dead and skinned ones as well. Figure 1 indicates that this was true throughout the whole period of desiccation. From the evidence obtained from the skinned frogs it appears that the ease with which water is lost through evaporation by a species is a function not only of the skin but also of the deeper tissues of the body.

SUSTAINED ADJUSTMENT TO DESICCATION

Although the adjustment demonstrated above does not appear to be important in

conserving water while desiccation is in progress, the possibility still remains that, having undergone water loss, a more or less prolonged resistance to desiccation might be induced. A series of experiments was designed to test this. Desiccators employed were of 3.6 liters capacity. Through these flowed two liters of acid-dried air per minute. One hundred and thirty-two *Rana pipiens*, 34 *R. clamitans*, and 47 *Scaphiopus hammondi* were used. They were first dehydrated, one at a time, for various lengths of time, some to a loss of only a few percent of the original body weight, others to greater losses, extending up to, and in some cases beyond, the lethal point. Those that survived were returned to water and allowed to regain their lost weight. Forty-eight hours after the beginning of the first desiccation, each of the surviving animals was redesiccated for exactly the same period of time as in the first experiment. It was then determined in each instance whether losses during the second desiccation differed from those of the first. The results appear in Fig. 3. The curve for each species is based on the number of experimental animals indicated above. The abscissas represent the percentage of body weight lost during the first desiccation and the ordinates (in relation to the horizontal line) how many percent more or less was lost in the second desiccation than in the first. Because of the large number of experimental animals employed, points for individuals are not shown on the graphs. The first part of the curve for *Rana clamitans* is shown slightly above the base line only to distinguish it from the latter, since this portion of the curve in reality lies directly on this line.

In all three species a definite adjustment was evident. In *R. clamitans* and *S. hammondi*, it was clearly in the direction of water conservation since, when there was a difference between the first and second water losses, the second was less than the first. In the former species, this adjustment occurred only in animals which underwent an initial water loss of more than 20 percent of the body weight, while in *Scaphiopus* the adjustment occurred in all animals regardless of whether the first desiccation was mild or severe. In *R. pipiens*, a water conserving adjustment was apparent after severe initial desiccation (over

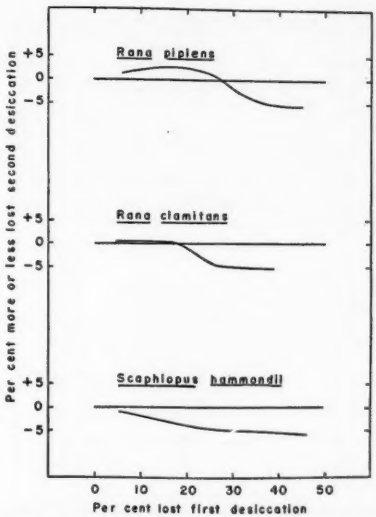

Fig. 3. Graphs showing the tendency of amphibians of three species to lose water at an altered rate after preliminary desiccation. Frogs were re-desiccated 48 hours after an initial desiccation that had been followed by recovery of water. Abscissas indicate percentage of original weight lost in first desiccation, and ordinates, the percentage to which a second desiccation of equal duration differed from the first. Each curve is based on from 34 to 132 experiments.

27 or 28 percent) but after milder desiccation the opposite effect occurred, i.e., increased water dissipation.

The water conserving regulation shown can readily be assigned significance in the development of amphibian terrestrial habits since any mechanism which reduces water loss is presumably of advantage to these animals out of water. It would appear that *S. hammondi* is better adapted in this respect than the other two species, for its water conserving mechanism came into play even after mild water loss. The ecological significance of the water dissipating action of *R. pipiens* remains obscure. However, this phenomenon may be related to the observation pointed out in the preceding section that the water dissipating period of live *R. pipiens* was more distinct and prolonged than that of either *R. clamitans* or *S. hammondi*.

To determine how long the adjustment to desiccation was sustained, experiments were performed on three more series of *R. pipiens*

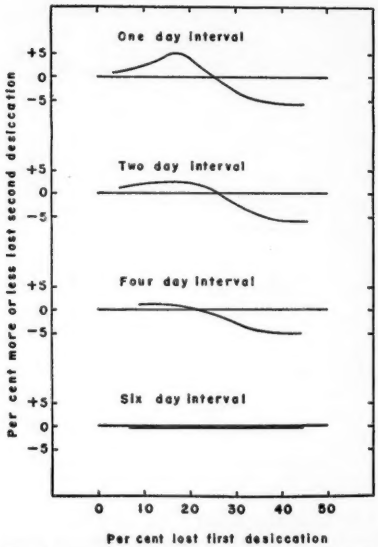

Fig. 4. Comparison of adjustment to desiccation in *Rana pipiens* when interval between two successive desiccations was varied (one, two, four and six days). Abscissas and ordinates as in Fig. 3.

in which each animal was subjected to two equal periods of desiccation separated by one, four, or six days. These data are compared (Fig. 4) with those for the two-day interval for *R. pipiens*. It is apparent that both types of adjustment were most pronounced after one day. The water dissipating portion of the curve diminished progressively through the fourth day and disappeared entirely before the end of six days. The water conserving effect was somewhat more persistent, but it also disappeared completely by the end of the sixth day.

Summary

Contrary to earlier reports, changes in the rate of water loss during desiccation appeared to take place in the three amphibian species studied. However, the changes were not primarily of a water conserving nature. A comparatively brief initial reduction in the rate of water loss was followed by an extended period of more rapid dissipation of water than occurred in dead animals. The latter change can scarcely be considered favorable to the development of terrestrial habits among amphibians. It appears probable that the changes in rate of water loss result from changes in the permeability of the skin to water.

From experiments on skinned frogs it appeared that the rate at which water is lost through evaporation is a function not only of the permeability of the skin but also of the deeper tissues of the body.

After an initial desiccation followed by the recovery of body water, subsequent water loss tended to take place at an altered rate in the amphibians studied. If the initial water loss was severe, the alteration tended toward water conservation. This adjustment of the rate of water loss would appear to have adaptive value in a terrestrial habitat. However, after mild desiccation, the adjustment varied. In *Scaphiopus hammondi*, a species independent of open water except for breeding, this adjustment was also of a water conserving nature. In *Rana clamitans*, an aquatic species, no adjustment appeared to take place after mild desiccation, whereas in the semiaquatic *Rana pipiens*, the regulation was in the direction of water dissipation. The significance of the latter reaction remains obscure. In *R. pipiens*, the adjustment was evident for at least four days, the water conserving action being somewhat more persistent than the water dissipating effect.

Acknowledgments

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DEPARTMENT OF ZOOLOGY, UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA.

Information from Studies of Marked Fishes[1] in the Alaskan Arctic

DONALD E. WOHLSCHLAG

THE purpose of this discussion is to call attention to some of the results, possibilities, and technical aspects of ecological studies involving the first mark-and-recapture observations on fishes in Alaskan arctic fresh and coastal marine waters. It is hoped that this report will also serve as a preliminary guide for future work by indicating what difficulties might be expected in similar studies on small and dispersed populations under arctic conditions.

During the summer of 1952 a mark-and-recapture study of population size and mortality rates was made for the two whitefishes (Coregonidae) of freshwater Ikroavik Lake (Wohlschlag, 1953, 1954a). A few fish were also captured, marked and released in a small tidal estuary of Elson Lagoon known as the "Slough". (These locations are shown in Figure 1.) Technical difficulties would prevent sampling beyond the two- to three-month ice-free season if additional sampling were required, and the extension of marking studies over more than one year would require a careful appraisal of the necessary assumptions underlying mark-and-recapture procedures (Ricker, 1948). At the time of the original marking operations, there was no direct way to evaluate the assumptions associated with the problems of permanence of fin clips or tags, of the nature of any possible migratory tendencies, or of sampling the marked and unmarked fish at random. By resampling the same populations again in 1954 and upon acquiring additional information from the Eskimo, a rare opportunity of evaluating these problems was provided.

Although there has been extensive elaboration of the statistical theory underlying mark-and-recapture studies, there are no *a priori* solutions to the problem of how many fish must be marked and recaptured for satisfactory estimates of population size (Chapman, 1952, 1954) or of mortality, growth and recruitment, and migration rates. Therefore, any preliminary information from the results of earlier mark-and-recapture investigations can be of inestimable value for the planning of more extensive operations.

Coregonus sardinella VALENCIENNES IN IKROAVIK LAKE

Ikroavik Lake (Figure 1) is uniformly about seven to seven and one-half feet deep over most of its 1000-acre area. Its drainage basin is very small, and its shallow, meandering outlet freezes solidly in winter. The winter volume of the lake is drastically reduced by a six-foot ice cover. This lake, like many others of the region, is known to contain fish populations supposedly little influenced by migrations.

By the use of mark-and-recapture techniques, the 1952 summer *Coregonus sardinella* population was estimated at about 5700 fish whose fork lengths were 180 millimeters or more, the

[1] Support for this study was provided by the Arctic Institute of North America, Project No. ONR-125. Initial marking and tagging studies in 1952 were supported by Contract Nonr-225(08) between the Office of Naval Research and Stanford University.

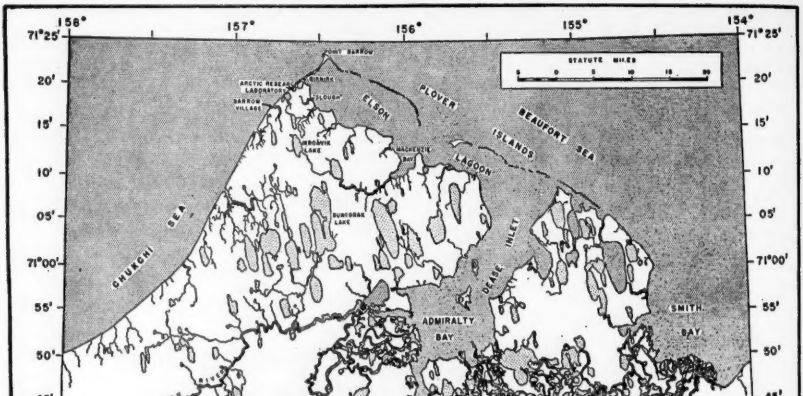

Fig. 1. Map of northernmost Alaska showing major lakes and drainage systems. Thousands of lakes and ponds lacking external drainage are not shown.

annual mortality rate was estimated at 0.59, and the daily summertime mortality rate was nearly 0.01 per day over a nine-week period (Wohlschlag 1953, 1954a).

This species was marked by clipping paired fins only at the tips. From a 4–10 September, 1952 sampling of 372 fish, there were removed 19 recaptured fish of a possible total of 288 previously released marked fish; thus 269 marked fish would have been at large if summer mortality were ignored. Among the recaptures, there was evidence of slight healing of the fins, but there was no evidence of regeneration.

From a sample of 196 *C. sardinella* taken in September, 1954 and consisting of fish 180 millimeters or longer, there was a single recapture whose clipped fin had not regenerated. The catch per unit of effort for this sampling was nearly identical with that for September, 1952.

At the rate of 0.59 mortality per year, the 269 marked fish possibly at large in September, 1952 would have been reduced to about 45 two years later. If mortality took place at this rate, if the recruitment at the 180 millimeter level were such that the population size remained constant (5700), if there were no regeneration of clipped fins, if there were neither immigration nor emigration, and if the marked fish were randomly distributed among the unmarked fish, the expected number of recaptures in the 1954 sample of 196 fish would be 1.5 with 0.99 confidence limits between 1.0 and 2.2. Since one recapture was actually observed, since 1952 and 1954 catches per unit of effort indicated similar population sizes for the two years, and since there was no evidence to indicate that migrations occurred, it would seem likely that the population of *C. sardinella* over 180 millimeters long remains fairly constant and isolated in the lake and that the mortality rate of 0.59 per year is reasonable. Had there been either wholesale regeneration of clipped fins or migrations there would have been little likelihood of obtaining any recaptured fish.

Coregonus nasus kennicotti Milner in Ikroavik Lake

The 1952 population whose members had fork lengths of 180 millimeters or more was estimated to be only 189 with 0.95 limits of 102 to 441; certainly the population was not

any larger than 600 (Wohlschlag, 1953). From a 4–10 September, 1952 sample of 31 fish, there were recaptured two tagged and three fin clipped specimens from a possible total of 10 tagged and 25 fin clipped fish at large. After the 1952 sampling with some removals, there was a possible total of 9 tagged and 20 fin clipped *C. nasus* at large, ignoring mortality during the time of marking operations. A September, 1954 sample of 18 *C. nasus* contained two tagged and three fin clipped fish.

The tags used were 3/8 inch red cellulose nitrate Petersen discs secured through the dorsal muscles beneath the dorsal fin with pure nickel wire pins. Each tag was hand numbered with white cellulose acetate ink. Over the two-year period the tags and numbers, as well as the pins, remained in excellent condition. Because of the difficulty of using tags in cold weather, various combinations of adipose and paired fins were clipped. Over the two years the partially clipped paired fins or the completely clipped adipose fins showed no evidence of regeneration.

Of the two tagged fish recaptured in 1954, one was a 2975-gram 16 year old female whose fork length had increased from 523 to 559 millimeters; the other was a 1990-gram 15 year old male whose length had increased from 504 to 507 millimeters. (The 1952 weights were inadequately determined for an assessment of weight gains.) In 1954 one 12 year old female fin clipped recapture had a fork length of 458 millimeters and a weight of 1375 grams; this fish could have been one whose 1952 length and weight were either 396 millimeters and 822 grams or 392 millimeters and 900 grams. The second 1954 fin clipped recapture was a 10 year old male which had a fork length of 415 millimeters and a weight of 1040 grams, an increase from 337 millimeters and 480 grams in 1952. The third fin clipped recapture, an 11 year old female, had increased in fork length from 470 to 505 millimeters and in weight from 1390 to 2065 grams since 1952. For each of these recaptures it was possible to match well the successive scale radii and annuli with scales from the same individuals in 1952. This type of coordination confirms the validity of the scale-growth and age-growth analysis used by Cohen (1954). These data also indicate clearly that the growth of the middle-aged *C. nasus* is relatively rapid while the growth of the old fish is much slower.

The same marking data also yield valuable information on population size and mortality rates. For *C. nasus* with fork lengths over 180 millimeters, the September samplings indicated that the ratio to the *C. sardinella* was 0.083 in 1952 and 0.092 in 1954. Thus the two populations remained in about the same proportion to each other; and on the basis of mortality and catch per unit of effort data they remained at about the same level. It is interesting to note that the proportion of recaptures among the unmarked *C. nasus* in September, 1952 (5 out of 31) was *less* than the proportion in 1954 (5 out of 18). For a small population of old fish, these different proportions could be explained by random variation in sampling provided that natural mortality over the two-year period had been very low. That this proviso is correct is indicated by the age-frequency data of Cohen (1954).

Coregonus sardinella in Coastal Waters of Elson Lagoon

Experimental fishing in northern Elson Lagoon has indicated that this species occurs regularly in small schools as soon as the ice breaks up in July and that it disappears gradually after the beginning of cold weather in September. Examination of several hundred specimens has shown that gonadal maturity does not occur here among sexually mature adults. Cohen (1954) also noted that very few *C. sardinella* younger than five years old existed in this area. For these reasons it must be concluded that *C. sardinella* must migrate elsewhere to spawn. The Eskimo recognize this distributional pattern from their observations of what appear to be autumn spawning migrations up the major rivers entering the Admiralty Bay region and from their observations of young fish in these rivers. Walters (1955) has suggested the hypothesis that it is necessary for *C. sardinella* and other salmonoid species to leave marine waters in winter to avoid freezing of body fluids at temperatures which approach minus 2° centigrade.

An attempt was made in July 1952 to estimate the size of one transitory population of *C. sardinella* by means of tagging studies in a portion of Elson Lagoon known as the "Slough." The Slough is a tidal estuary about one mile long. It is the drainage outlet of a large swampy area near Point Barrow. The width at

the mouth is about 350 yards, but, except for a 20-foot wide scour channel, the estuary is separated from the Lagoon proper by a long sandspit. The maximum depth at the scour channel is about five feet. The salinity of the Slough ranges from around zero where the swamp drainage enters to about 21 parts per thousand at the scour channel. This small estuary is typical among many along the Alaskan arctic coast.

A partially successful attempt was made to block completely the scour channel while marking operations were conducted within the Slough. During one week about two hundred fish were taken in the blocking gill net, while only 38 *C. sardinella* were seined, tagged with Petersen discs as described above for *C. nasus*, and released within the Slough. By the end of the week the movement of this species to and from the Slough had virtually ceased and no recaptures had been taken.

Later, it was discovered that two of the 38 tagged fish had been recaptured among a few hundreds of *C. sardinella* taken by a native fishing in the Meade River near the village of Atkasuk (Figure 1) during October, 1952. The distance from place of release to place of recapture would be about 100 miles. The occurrence of these two recaptures is the first direct evidence of the migratory nature of the populations in northern Elson Lagoon and its tributaries. It is remarkable that, of all the many available distributary streams and channels of the Admiralty Bay area, some of the 38 tagged *C. sardinella* would have moved up the Meade River where there happened to be a small fishery.

Other Fishes in the Vicinity of Northern Elson Lagoon

The ubiquitous *Myoxocephalus quadricornis* (Linnaeus) are rather uniformly distributed and quite abundant in the shallow waters of northern Elson Lagoon. They also occur during midsummer in the Slough where 52 specimens over 150 millimeters long were marked by clipped fins during the week that the Slough was partially blocked off from the Lagoon. On the last day of sampling the appearance of two recaptures in a sample of 15 would indicate a population of the order of 390 fish in the Slough. However, these sculpins were observed to enter and leave the Slough at a rate of five to ten per day so that this population estimate would be slightly biased upward.

In Elson Lagoon waters mark-and-recapture studies might be applied also to *Coregonus autumnalis* (Pallas), which occurs in approximately the same order of abundance and which has about the same habits and distribution as *C. sardinella*. The other anadromous species are taken occasionally in small numbers only. They include the salmons, *Oncorhyncus keta* and *O. gorbuscha*, and the charrs, *Salvelinus malma* and *S. alpinus*.

Possibilities of Studies Based on Marked Fishes

Although all evidence presently available indicates that the individual populations of coastal and inland arctic Alaskan fish species are relatively small, there are many such populations in the large numbers of lakes and coastal areas that could be exploited simply because some of the species like the whitefishes can be taken in fair quantities during short seasonal periods of concentration. In such circumstances catch-effort data would give a false impression of abundance without supplementary information such as that derived from mark-and-recapture studies. This would be true even if the absolute numbers of fish from any one population which were observed, marked, and recaptured were necessarily small.

From the preceding discussion of the resampling and re-evaluation of the mark-and-recapture data on the two whitefish species in Ikroavik Lake, it appears that all necessary assumptions given by Ricker (1948) for mark-and-recapture procedures can be fulfilled in similar lakes with isolated populations. That the lakes of northern Alaska tend to have whitefish populations whose members are fatter and deeper-bodied than their anadromous counterparts is also evidence for isolation of lake forms as shown for the Barrow region by Cohen (1954) and Wohlschlag (1954b). Thus it may be concluded that the newer mark-and-recapture techniques, such as those given by Bailey (1951), Chapman (1952, 1954), Leslie and Chitty (1951), Leslie (1952) and Leslie *et al.* (1953), could be successfully applied to many of the lake fish populations of the arctic Alaskan slope.

However, it would be most difficult to apply

these techniques to marine coastal populations because of their transitory nature. More localized populations like the sculpins might be studied by the marking methods suggested by Ketchen (1953), but similar procedures could be applied to the more widely ranging anadromous salmonoids only after an investigation of the spacial delimitations of individual populations. Not only would sampling of small migratory schools be difficult, but it would be quite difficult to sample extensively in much of a complex distributary system like that entering Admiralty Bay (Figure 1). Although waterways of this type could allow populations to be extremely dispersed, it should be pointed out that the shallower streams and sloughs freeze solidly and that only the larger and deeper channels of the rivers are known at present to contain substantial anadromous populations.

Acknowledgments

Field work was conducted with the help of Mr. Daniel Cohen in 1952 and Mr. Warren Freihofer in 1954 along with the generous aid and logistical support of the Arctic Research Laboratory staff at Point Barrow. Mr. Norman J. Wilimovsky checked the identification of the specimens whose nomenclature follows the list of Wilimovsky (1954). Mr. Cohen, Mr. Paul M. Bruns, and Miss Gretchen Gilkey aided in the preparation of the data.

Summary

Marking of larger whitefishes in arctic lakes is possible either by fin clipping or by use of plastic Petersen discs. After a period of over two years, partially clipped paired fins and completely clipped adipose fins did not regenerate and cellulose nitrate discs with nickel wire fastenings did not deteriorate.

Two years after initial mark-and-recapture studies in Ikroavik Lake, the results of a resampling indicated that the population of *Coregonus sardinella* over 180 millimeters long must have remained isolated in the lake, must have remained at about the same population level (5700), must have retained about the same level of annual mortality (about 0.59 per year), and must have remained in a fairly uniform distribution within the lake. Likewise the population of *Coregonus nasus* over 180 millimeters long seemed to remain constant (less than 600) and isolated over the two-year period during which a very low mortality rate for the larger fish was indicated. For five individually recognizable recaptures, there was rapid growth for the middle-aged fish and very slow growth for the oldest and largest fish; for these same recaptures, scale annuli were compared for both the 1952 and 1954 scales with a clear indication that the scale method of age and growth determinations was valid. It is concluded that similar fish populations of many arctic Alaskan lakes could be studied by means of mark-and-recapture techniques for estimates of population size, mortality rates, and growth and recruitment rates.

A mark-and-recapture estimate was also made for the population size of the sculpin, *Myoxocephalus quadricornis*, in a mile-long shallow tidal estuary of Elson Lagoon near Point Barrow during July, 1952. With the use of fin clip marks, the estimate was around 400 fish over 150 millimeters long. This population was transitory, and for the most part gradually filtered back into Elson Lagoon later in the summer. During the same time, 38 *Coregonus sardinella* were captured and released with numbered tags. About three months later, the recapture of two of these specimens in the Meade River provided evidence that this species, which exists in small schools in the marine waters of northern Elson Lagoon in summer but which disappears later, tends to move up major streams in autumn spawning migrations.

Some of the anticipated difficulties of mark-and-recapture procedures for studying small, transitory, and widely dispersed populations in coastal waters are discussed.

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NATURAL HISTORY MUSEUM, STANFORD UNIVERSITY, STANFORD, CALIFORNIA.

New Records of Deep-sea Fishes, including a New Species, *Oneirodes bradburyae,* from the Gulf of Mexico

MARION GREY

THE fishes reported here were taken in deep-water hauls made by the U. S. Fish and Wildlife Service research vessel OREGON in the Gulf of Mexico, where these species have been unknown until now.

MICROSTOMATIDAE

Microstoma microstoma (Risso)

STUDY MATERIAL.—One specimen, OREGON St. 1234, 22°N., 96°38′W., 27 January 1955, taken in a dip net from the surface at night, over a depth of 1200 fathoms.

DESCRIPTION.—Counts, proportions and comparisons with data of Brauer (1906: 10), Moreau (1881: 357) and Maul (1948: 36) are shown in Table 1.

The top of the head is flat, with several small pores between the eyes anteriorly, on the snout, on the head below and behind the eye, and on the lower surface of the lower jaw. Both nostrils are situated at the tip of the snout, the anterior one the larger. The lateral line is a broad, deep groove covered with enlarged scales. Posteriorly on the caudal peduncle these scales are transparent and beneath each one is a brilliant silver spot surrounded with black pigment. This posterior part of the peduncle is blackish (area of the last 18 lateral line scales and base of caudal fin where scales extend onto it), whereas the remainder of the body is a brilliant silver. The lateral line scales are adherent, the others deciduous and mostly lost. The specimen is apparently essentially identical with previously described examples, although Maul has written (1955, in litt.) that the Madeiran specimen has pores only on the snout and lower jaw, not elsewhere on the head.

COLOR.—Body bright silver when scaled. Lower surface in front of ventral fins a mixture of black and silver pigment and with a narrow, intense black stripe, outlined on either side by a whitish or silvery band, along the mid-line from below pectoral fins almost to ventral fins. Head dark except translucent snout. Peritoneum, inside of mouth and gill-covers, black.

DISTRIBUTION.—*M. microstoma* was first described from the Mediterranean, where it occurs in deep water from Spain to the Dodecanese Islands (Schmidt, 1918: 28). Only two specimens have been recorded outside the Mediterranean, one from the Gulf of Guinea in an intermediate net fished at a depth of 600 meters, bottom 710 meters (Brauer, 1906) and one from Madeira, depth and mode of capture unknown (Maul, 1948). The present example is the first report from the western Atlantic.

FIG. 1. *Microstoma microstoma* (Risso). CNHM No. 59994, 162 mm. standard length.

Figure 1 was prepared by Mr. Tom Dolan, to whom I would like to express my appreciation.

GONOSTOMATIDAE

Valenciennellus tripunctulatus (Esmark)

One specimen, standard length 28.5 mm. OREGON St. 1028, 28°28′N., 87°18′W., 21 April 1954, 780 fathoms.

DISTRIBUTION.—The species is said to be widely distributed in the Indo-Malayan region, the Indian Ocean, and the tropical and subtropical Atlantic. The only definite western Atlantic localities previously recorded were off Bermuda and in ca. 20°N., 61°W.

STERNOPTYCHIDAE

Argyropelecus gigas Norman

One specimen, standard length 91 mm., OREGON St. 841, 25°58′N., 88°W., 6 October 1953, 830–930 fathoms.

One specimen, standard length 95 mm., OREGON St. 1302, 28°53′N., 87°58′W., 26 May 1955, 890 fathoms.

DISTRIBUTION.—Only five specimens of *A. gigas* have been reported previously: two from Madeira; two off the coast of Africa in ca. 6°N., 15°W. and ca. 2°S., 9°W.; and one in the south Atlantic northwest of Tristan da Cunha (ca. 32°S., 8°W.).

MORIDAE

Melanonus unipennis Beebe

One specimen, standard length 77 mm. OREGON St. 841, 28°58′N., 88°W., 6 October 1953, 830–930 fathoms.

DISTRIBUTION.—Originally described from Bermuda, *M. unipennis* has since been recorded from the central and eastern Atlantic between 31° and 37°N., 29° and 47°W. A specimen reported as *M. gracilis* Günther from the western Atlantic in ca. 40°N., 56°W. may prove to be *M. unipennis* also (Roule and Angel, 1933: 66).

TABLE 1

COUNTS AND PROPORTIONS OF *Microstoma microstoma*

Author	Brauer*	Moreau †	Oregon	Maul‡
Standard length, mm.	105	160	162	197
Dorsal rays	10	9–11	11	11
Anal rays	7	8–9	9	8
Pectoral rays	7	8	8	8
Ventral rays	10	10–11	10	11
Lateral line	53	44–52	53	52
In standard length, percent				
Depth	8.56	7.5	9.58	—
Head	20.9	17.5	20.6	—
Snout	3.8	3.75	4.2	—
Eye	7.6	6.25	7.41	—
Snout to ventral	64.0	62.5	57.4	—
Snout to dorsal	67.6	65.0	61.8	—
Snout to anal	79.0	78.2	76.9	—
Least depth of caudal peduncle	4.76	—	4.32	—
Dorsal base	9.5	7.5	9.27	—
Anal base	4.76	5.0	3.7	—
In standard length, mm.				
Head	4.8	5.7	4.85	5.33
Depth	11.7	13.3	10.5	10.5
In head, mm.				
Snout	5.5	4.65	4.9	4.0
Eye	2.75	2.8	2.8	2.6

* 1906: 10.
† 1881: 357.
‡ 1948: 36.

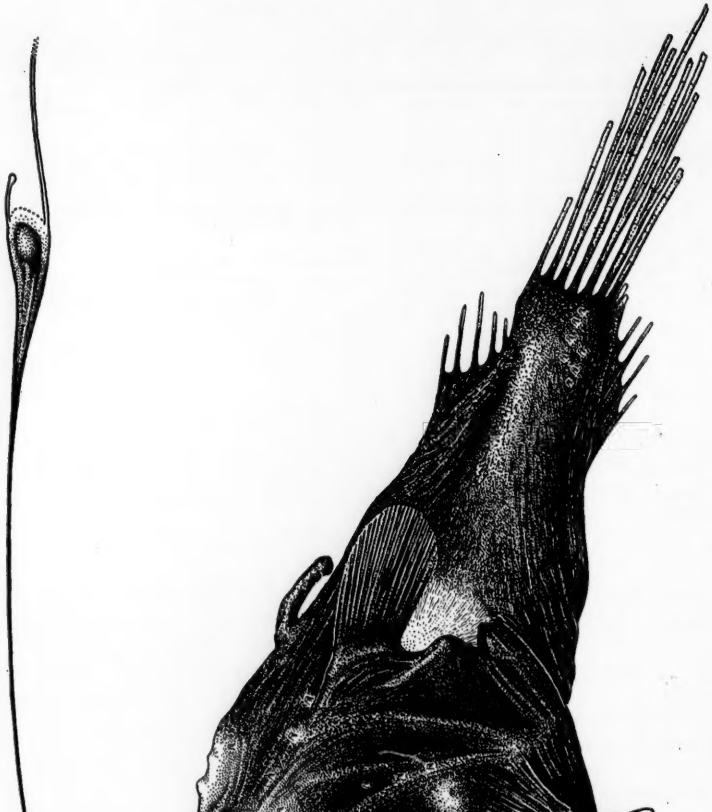

FIG. 2. *Oneirodes bradburyae*, sp. nov. Holotype, USNM No. 164359, 23.6 mm. standard length.

DIRETMIDAE

Diretmus argenteus Johnson

One specimen, standard length 167 mm., OREGON St. 635, 29°12′N., 87°49′W., 18 September 1952, 370–450 fathoms.

DISTRIBUTION.—*D. argenteus* is a widely distributed species with records from the Arabian Sea in the Indian Ocean; Australia, New Zealand and Japan in the Pacific; and in the Atlantic from near the Faroe Islands (62°N.), from the Gulf of Gascony to Cape Point and, in the central and western Atlantic, from about 34°N., 33°–47°W. to Bermuda and the Bahamas.

TRIACANTHODIDAE

Hollardia hollardi Poey

One specimen, standard length 124 mm., OREGON St. 1054, 19°37′N., 92°40′W., 15 May 1954, 200 fathoms.

DISTRIBUTION.—This specimen does not, perhaps, constitute a new record for the Gulf of Mexico as the type was found cast ashore at Havana, Cuba. Only three other specimens are known, one from Bermuda and two probably caught north of Glover Reef, British Honduras.

ONEIRODIDAE

Oneirodes bradburyae sp. nov.

STUDY MATERIAL.—Holotype, U.S.N.M. No. 164359, OREGON St. 1028, 28°28′N., 87°18′W., 21 April 1954, 780 fathoms.

DESCRIPTION.—Total length 33.4 mm. Standard length 23.6 mm. D. 5. A. 4. C. 9. P. 14. Measurements in percent of the standard length: Head 66.2, lower jaw 42.4, eye 7.64, cephalic spine including base 9.34, mandibular spine 6.79, basal bone of illicium 48.4, illicium including esca but excluding filaments 73.8, longest filament 15.7, total tentacular apparatus 138.0.

Measurements in percent of head length: Lower jaw 64.2, eye 11.5, cephalic spine 14.1, mandibular spine 10.25.

Body slightly damaged and somewhat distorted. A partially invaginated tentacle on back above pectoral base. Lateral line system represented by small tubes, more numerous on head than on body, two short rows on lower part of caudal peduncle.

Cleft of mouth reaching well past eye. Teeth slender, nearly all depressible, long and short intermixed in both jaws, 14 on left sides of both upper and lower jaws. Mandibular spine double, the smaller spine concealed by skin on one side. Mandible itself with a blade-like expansion posteriorly, below the spine. Entire illicium, including filaments, exceeding standard length. Exposed part of basal bone long, its posterior end protruding on the back. Illicium stem brown. Esca compressed, transparent, the relatively large inner body black. A rather long, fine filament arising from left side of distal end of esca; a shorter, club-tipped prolongation on right side; and a short, delicate cluster of filaments centrally; all filaments colorless. Some of these filaments could not be shown on the drawing (Fig. 2). After the description was written the esca was accidentally dried out and the filaments hardened and shriveled.

Remarks.—The specimen is clearly referable to the genus *Oneirodes* as defined by Bertelsen (1951:76) but differs from all known species of the genus in the extraordinary length of the illicium and basal bone. Only four oneirodids possess such a relatively long illicium, *Dolopichthys danae* Regan, *D. allector* Garman, and two species of the genus *Lasiognathus*. From the latter *O. bradburyae* differs in many respects and from the two former it is distinguished not only by the characters that separate *Oneirodes* from *Dolopichthys* (wider mouth opening, exserted posterior end of basal bone, etc.) but also in the structure of the esca and the number of fin-rays. The exaggerated expansion on the lower end of the lower jaw is found also in *Dolopichthys longicornis* Parr, *D. allector* Garman and *Microlophichthys microlophus* (Regan).

O. bradburyae is named for Miss Margaret Bradbury, who prepared the figure of the type specimen.

FIG. 2. *Oneirodes bradburyae*, sp. nov. Holotype, USNM No. 164359, 23.6 mm. standard length.

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CHICAGO NATURAL HISTORY MUSEUM, CHICAGO 5, ILLINOIS

Ichthyological Notes

NOTES ON THE IDENTITY OF SEVERAL SALARIINE BLENNIES OF THE GENUS *SCARTICHTHYS* FROM WESTERN SOUTH AMERICA.—At least nine species of fishes have been described as salariine blennies from the coasts of Chile and Peru and from islands off that coast. Many of the species have long been known from few specimens and in some instances from only a single example. Recent examination of specimens in the collections of the Stanford Natural History Museum, the Academy of Natural Sciences of Philadelphia, the California Academy of Sciences and the U. S. National Museum has shown that some of the described species are not valid.

There has been some disagreement as to the proper generic designation for this group of blennies. The problem is not discussed in the present paper. The name *Scartichthys* Jordan and Evermann, as defined by Norman (1943, Ann. Mag. Nat. Hist., 11 (10): 807) has been accepted.

Steindachner (1876, Sitzb. math.—naturw. Cl. k. Akad. Wiss. Wien, 74: 220) described *Salarias gigas* from Callao, Peru, based on two specimens. In 1898 Steindachner (Zool. Jahrb., suppl., 4, 2: 307, figs. 5, 5a) described and figured *Salarias eques* from a single specimen collected at Cavancha Bay near Iquique in northern Chile. In the same work he recorded additional specimens of *S. gigas* from Cavancha Bay and illustrated the species (figs. 7, 7a). Hildebrand (1946, U. S. Nat. Mus. Bull. 189: 387) has recognized both *S. gigas* and *S. eques* from Peru. He notes that the two are extremely closely related and gives the differences found between a specimen of *S. eques* and a single specimen of *S. gigas* of approximately the same size. These concern proportions and color pattern.

In the 40 specimens of this species complex at hand, two well-defined color patterns are present. Both sexes are represented in each color pattern. One of these, seen in many of the smaller specimens (31.2 to 59.4 mm. standard length), is easily identified with Steindachner's (1898, *op. cit.*) figure of *S. eques*. In alcohol specimens, this pattern consists of a ground color ranging from medium chocolate brown to dirty brownish white, darker dorsally and paler ventrally. Imposed on this are two dark bands running the length of the fish. The upper band is immediately below the dorsal fin; it begins slightly before the dorsal origin and usually ends slightly before the posterior termination of the fin base. The lower and wider band may begin on the head, but more often behind it. The band runs straight back along the midline of the body and ends at the base of the caudal. The dorsal fin is pale brown, edged with white. A dark spot is present on the membranes between the first and third dorsal spines. Above the spot is a clear window in the membrane. A dark spot is also present on the head less than one eye diameter behind the eye.

A number of other specimens, generally larger (50.0 to 145.5 mm. in standard length), show the color pattern of *S. gigas* as given in Steindachner's (1898, *op. cit.*) illustration of the fish. A light brown color is heavily flecked with dark brown. The dorsal fin is dark brown with white edges. A dark spot is present on the membranes between the first and third spines in some specimens, not in others. The anal fin is darker than the dorsal. A postorbital spot is present.

A third color pattern is also present. This consists of intermediates between the color patterns of *S. eques* and *S. gigas*. In a typical intermediate specimen, the two dark brown bands are partly broken up by light areas. Those regions between the two dark bands and below the ventral dark band have been invaded by dark brown flecks. In several specimens a situation similar to that described by Hildebrand (1946, *op. cit.*) for juvenile specimens of *S. gigas* occurs, in which blotches from the two horizontal series unite to form poorly defined lateral cross bars. With the specimens available it is possible to show a very gradual change from the *S. eques* to the *S. gigas* type of color pattern within a single locality.

A comparison of the counts and measurements of 20 *S. gigas*-type specimens and counts and measurements given by Steindachner for *S. eques* and taken from his life-sized figure of *S. eques*, are as follows (fishes examined first, followed by *S. eques* in parenthesis): standard length, 50.0–128.5 mm. (87.5 mm.); dorsal, XII, 17–18 (XII, 17); anal, II, 18–19 (II, 18); principal caudal rays, 11 (11); pectoral, 14

(14); height into s.l., 3.5–4.35 (4.21); head into s.l., 3.30–3.83 (3.68); eye into head, 3.7–5.77 (4.36). *S. eques* falls within the range of variation of *S. gigas* for all the above-mentioned characters.

Another difference shown in Steindachner's figures of the two nominal species concerns the anterior profile of the head. He shows the profile of *S. eques* rather steeply and flatly decurved while the profile of *S. gigas* is considerably curved. The anterior profile seems to be a function of size. Smaller specimens have an even steeper profile than that shown in the figure of *S. eques*, while the larger specimens have a more rounded profile than that shown for *S. gigas*. Size intergrades between the two forms are present.

Characters such as the size of the fins, length of the supraorbital tentacles and length and number of nuchal cirri are so variable that they are of little taxonomic value here.

The above evidence indicates that *Scartichthys eques* is not a valid species and should be placed in the synonymy of *Scartichthys gigas*.

Fowler (1941, Proc. Acad. Nat. Sci. Philadelphia, 42: 189, fig. 18) described *Salarias petersoni* from a single specimen, 46 mm. in standard length, taken at Antofagasta, Chile. Although the color pattern of the specimen has faded, it resembles the *eques* pattern of *Scartichthys gigas*. The fish has two lateral stripes, a dark spot behind the eye, and a dark spot at the beginning of the dorsal fin. The profile is steeper than Fowler's figure indicates. Following is a comparison of the counts and measurements of the holotype of *S. petersoni* compared with those of a series of *S. gigas* ranging from 30.6 mm. to 53.5 mm. in standard length (*S. gigas* first, followed by *S. petersoni* in parenthesis): dorsal, XII, 17–18 (XII, 18); anal, II, 18 (II, 18); principal caudal rays, 11 (11); pectoral rays, 14 (14); height into s.l., 3.71–4.73 (4.2); head into s.l., 2.76–4.07 (4.0). It is evident that *Salarias* petersoni also belongs in the synonymy of *Scartichthys gigas*.

The synonymy of *Scartichthys gigas* is then as follows:

Salarias gigas Steindachner, 1876, Sitzb. math.—naturw. Cl. k. Akad. Wiss. Wien, 74: 220 (original description, type locality Callao, Peru).—Steindachner, 1898, Zool. Jahrb. (supplement), 4: 309, taf. 19, figs. 7, 7a (Cavancha Bay near Iquique, Chile).—Delfin, 1901, Cat. de los Peces de Chile,: 92 (cites previous records).—Porter, 1909, Rev. Chilena Hist. Nat., 13 (4–5): 292 (listed).—Fowler, 1944, Acad. Nat. Sci. Philadelphia, Mon. 6: 522 (cites previous records).—Fowler, 1944, Boll. Mus. Javier Prado, Lima, Peru, 30 and 31: 283 (synonymy and previous records from Peru).

Scartichthys gigas Abbott, 1899, Proc. Acad. Nat. Sci. Philadelphia: 362 (Peru).—Hildebrand, 1946, U. S. Nat. Mus. Bull. 189: 387 (description, synonymy, Guanape Island, Samanco Island, Callao, La Lagunilla, San Juan Bay, Lobos de Afuera Island, Ballestas Island, Santa Rosa Island, all in Peru; Guayaquil, Ecuador).—Tortonese, 1947–49, Rev. Chileña de Hist. Nat., 51–53: 115 (Valparaiso, Chile).—Mann, 1950, Peces de Chile, Clave de Determinacion, Santiago, Chile: 17.—Mann, 1954, La Vida de los Peces en Aguas Chileñas, Santiago, Chile: 277 (listing, previous records, key).—Bini and Tortonese, 1955, Boll. di Pesca, Piscicoltura e Idrobiologica, ann. 30 (9 n.s.) 2: 34 (Chimbote, Peru).

Alticus gigas Evermann and Radcliffe, 1917, U. S. Nat. Mus. Bull. 95: 166 (description and synonymy, Chincha Island, Ballestas Island, Vieja Island, Independencia Bay, Santa Rosa Island, Lobos de Afuera Island, Chimbote, Peru).—Nichols and Murphy, 1922, Bull. American Mus. Nat. Hist., 46, (9): 513 (S. Chincha Island, Peru).—Fowler, 1944, Rev. Chileña de Hist. Nat., 46–47: 324 (synonymy).

Salarias eques Steindachner, 1898, Zool. Jahrb. (supplement), 4: 308, taf. 19, figs. 5, 5a (original description, type locality Iquique, Chile).—Delfin, 1901, *op. cit.*: 277 (previous records).—Steinitz, 1950, Arch. Zool. Italiano, 35: 336 (zoogeographical comments).

Scartichthys eques Abbott, 1899, *op. cit.*: 362 (Peru).—Fowler, 1916, Copeia, 34: 65 (listed).—Hildebrand, 1946, *op. cit.*: 389 (description, comparison with *S. gigas*).—Norman, 1943, Ann. Mag. Nat. Hist., 11 (10): 810 (listed).—Mann, 1950, *op. cit.*: 16.—Mann, 1954, *op. cit.*: 277 (listing, previous records, key).—Bini and Tortonese, 1955, *op. cit.*: 34 (description, Chimbote, Peru.).

Rupiscartes eques Fowler, 1926, Proc. Acad. Nat. Sci. Philadelphia, 78: 284 (description of a dried specimen, Valparaiso, Chile).

Alticus eques Fowler, 1944, Rev. Chilena Hist. Nat., 46–47: 325 (figure, synonymy).

Hepatoscartes eques Fowler, 1944, Acad. Nat. Sci. Philadelphia, Mon. 6: 522 (Iquique, Coquimbo, Coronel, Valdivia, Valparaiso, Chile).

?*Salarias rubropunctatus* Günther (in part), 1861, Cat. Fishes British Mus., 3: 249 (Chile).

Salarias rubropunctatus Tortonese (not of Cuv. et Val., 1836), 1939, Boll. Mus. di Zool. e Anat. Comp. della R. Univ. di Torino, 47, (3), 100: 202 (description, Valparaiso, Chile).

Salarias petersoni Fowler, 1940, Proc. Acad. Nat. Sci. Philadelphia, 92: 189, fig. 18 (original description, type locality, Antofagasta, Chile; holotype A.N.S.P. no. 69150).—Fowler, 1944, Acad. Nat. Sci. Philadelphia, Mon. 6: 522 (listed).—

Fowler, 1944, Rev. Chileña Hist. Nat., 46–47: 324 (figure, synonymy).—Mann, 1954, *op. cit.*: 277 (listed).

Scartichthys petersoni Norman, 1943, *op. cit.*: 810 (listed).

In his description of *Salarias petersoni*, Fowler compared it with *Salarias chiliensis* Clark (1938, Proc. California Acad. Sci., 4 (22) 7: 182), described from Valparaiso Harbor, Chile. Examination of the holotype and paratypes of *S. chiliensis* has shown that they are not salariine blennies but instead possess broad, chisel-like incisors firmly attached to the jaw, a characteristic of the Blenniinae. The gill membranes are broadly united to the isthmus and the gill openings similar to those in the *Hypsoblennius* group. (After examining the specimens, the author's tentative allocation was confirmed by the discovery in the bottom of the jar of a note signed by Dr. W. M. Chapman which stated that the specimens were the pelagic young of *Homesthes biocellatus*.)

A male specimen (males of this group have the first two anal spines modified into fleshy pads) of *Scartichthys viridis* was included in a collection of *S. gigas* from Independencia Bay, Peru. The following counts and measurements were made on the specimen: standard length, 122.5 mm.; dorsal, XII, 18; anal, II, 19; principal caudal rays, 11; pectoral rays, 14; height into s.l., 3.35; head into s.l., 3.88; eye into head, 4.85. Comparison of these measurements with those already given for a series of larger specimens of *S. gigas* shows proportional differences. The coloration is also different from that observed in any of the *S. gigas* at hand. No markings are present on the body of the fish. The color in alcohol is a dull brown, darker dorsally and paler on the ventrum. The anterior section of the dorsal fin is uniformly dark, the posterior tipped with white. The anal fin is dark brown with a slightly darker spot present on the membranes between each ray. A comparison between the single specimen of *S. viridis* and a specimen of *S. gigas* of the same sex and approximately the same size shows a striking difference in the anterior profile of the head. The profile of *S. viridis* falls quite steeply while the profile of *S. gigas* is much rounded. The distinction in the fishes examined is even more marked than Steindachner's (1898, *op. cit.* figs. 6a, 7a) illustrations show for the two species.

The following specimens were examined in connection with this paper: *Scartichthys gigas*, 1 specimen, University of Southern California 97-73, San Nicholas Bay, Peru; 17 specimens, USC 181-73, Independencia Bay, Peru; 1 specimen, USC 182-73, Lobos de Afuera Island, Peru; 3 specimens, Stanford University 48835, Montemar, near Valparaiso, Chile; 2 specimens, SU 37603, Lobos de Afuera Island, Peru; 1 specimen, SU 37604, San Juan Bay, Peru; 16 specimens, SU 37605, Independencia Bay, Peru (two of these cleared and stained); 1 specimen, U. S. Nat. Mus. 128195, N. Chincha Island, Peru; 1 specimen, Acad. Nat. Sci. Philadelphia 69150 (holotype of *Salarias petersoni*), Antofagasta, Chile. *Scartichthys viridis*, 1 specimen, SU 48836, Independencia Bay, Peru. *Homesthes biocellatus*, 1 specimen, California Acad. Sci. 5535 (holotype of *Salarias chiliensis*), Valparaiso Harbor, Chile; 6 specimens CAS 5536-554 (paratypes of *S. chiliensis*), Valparaiso Harbor, Chile; 1 specimen, CAS 5542 (paratype of *S. chiliensis*), Coquimbo Bay, Chile.

The author wishes to thank Drs. James Böhlke, Floyd Durham, W. I. Follett, and Leonard P. Schultz for permission to examine material. He is also indebted to Dr. W. M. Chapman for permission to refer to his comments on *Salarias chiliensis* and to Dr. George S. Myers for his critical comments.—DANIEL M. COHEN, *Natural History Museum, Stanford University, California.*

NOMENCLATURAL STATUS OF THE NAMES *BAGRE* CUVIER (OKEN), *BAGRUS* VALENCIENNES AND *PORCUS* GEOFFROY ST. HILAIRE.—While revising the siluroid fishes of the family Bagridae, it was found that Fowler (1935, Ann. Transvaal Mus., 16: 275; 1936, Proc. Acad. Nat. Sci. Philadelphia, 88: 309; and 1949, Proc. Acad. Nat. Sci. Philadelphia, 101: 261) inconsistently used the names Porcidae and Mystidae for the Family-Group name without assigning any reasons whatsoever. However, Jordan (1923, Classification of Fishes: 148), Berg (1940, Classification of Fishes: Both Recent and Fossil: 448) and others have applied the name Bagridae, which is in current usage.

Catesby (1731–43, The Natural History of Carolina, Florida and the Bahama Islands) proposed for the first time the name *Bagre* for *Silurus catus* Linnaeus (= *Ictalurus catus*) and used polynomial phrases for his species. Edwards (1771) in the third edition of Catesby's work republished the names without following the Linnaean system, particularly in regard to *Bagre*. Opinions 89 and 259 of the International Commission on Zoological Nomenclature invalidate both Catesby's and Edwards' work.

Cuvier (1817, Le Règne Animal, Ed. 1, 2: 204) proposed the name "Les Bagres" for fishes like *Silurus bagre* Linnaeus (= *Felichthys marinus*). Oken (1817, Isis: 1182) published Latin equivalents for all such French names given by Cuvier and thus emended Les Bagres to *Bagre*. Cuvier and Oken adopted the Linnaean system and hence their works are admissible under the Rules. The earlier name *Bagre* Catesby being invalid, Cuvier's generic name

as emended by Oken is now used in place of the generic names *Felichthys* Swainson and *Ailurichthys* Baird belonging to the Tachysuridae.

Geoffroy St. Hilaire (1818, Description de l'Egypte: 302) proposed the genus *Porcus* for *Silurus bayad* Forskål and similar fishes. Valenciennes (1839, Histoire Naturelle des Poissons, 15: 388) proposed independently the name *Bagrus* for the same fish. Both names were validly proposed and are available under the Rules.

Jordan (1919, The Genera of Fishes, 2: 194) opined that *Porcus* Geoffroy St. Hilaire had precedence over *Bagrus* Valenciennes but erroneously stated that "*Bagrus* is regarded as preoccupied by *Bagre*, both being forms of 'Les Bagres' Cuvier". So far as Oken emended Les Bagres to *Bagre*, the latter name becomes valid, and as shown is applicable to a different group of fishes (Tachysuridae). As valid generic names, each with a distinct spelling, one cannot be stated as preoccupied by the other, even though they are different forms of Les Bagres.

According to the law of priority *Porcus* must replace *Bagrus* for this group of fishes. However, *Bagrus* is only a junior subjective synonym of *Porcus*, since the two names are not based on the same type material. So long as junior subjective synonyms remain a valid source of family names (1953, Copenhagen Decisions of Zoological Nomenclature: 36, paragraph 54, section 1a), the name of the Family-Group taxon based on *Bagrus* may be retained. There is thus no need to replace the well-known name Bagridae at the present time.—K. C. JAYARAM, *Zoological Survey of India, Indian Museum, Calcutta, India.*

A SOUTH FLORIDA RECORD FOR THE STINGRAY, *DASYATIS CENTROURA*.—On March 15, 1955 a large stingray was captured in 200 feet of water at the edge of the Gulf Stream three and a half miles due east of the city of Miami by Capt. C. S. Loveland of the charter boat "Melody". Because of the large size of the ray (exact measurements not recorded) and the singular appearance of its tail, this member was severed and sent to the taxidermy shop operated by Mr. E. Ross Allen at Miami, to whom I am indebted for lending me the tail for identification and measurements, which appear below. The tail is from a large example of *Dasyatis centroura* (Mitchill), and is easily identifiable from the large number of thorny denticles with which it is covered to its tip, the denticles being of mixed sizes but much larger on the dorsal surface. The tail appears to be a near-perfect specimen and was evidently severed quite close to the body so that a reasonably accurate estimate of its total length may be given. To a distance of about 9 inches below the tip of the stinging spine the tail is skinned out and the skin spread sideways for drying; below this the tail remains intact and only slightly shrunken in desiccation. The total length is 6 feet 8 and ¼ inches and the width of the skin at the base, which gives a measure of the basal circumference is 12 and ¾ inches. The stinging spine is 5 and ¼ inches in length and measures ½ inch across its base, and is asymmetrical, being curved slightly to the left. No trace of a supernumerary spine or spines appears. Bigelow & Schroeder (1953, Fishes of the Western North Atlantic, 2: 359) give the range of *Dasyatis centroura* as follows: "Coastal waters of the Western North Atlantic from Georges Bank and Cape Cod to Chesapeake Bay, to Cape Hatteras, possibly to Florida." I believe this to be the first definite record of this species from south Florida, and although this particular specimen was not photographed, Capt. Loveland showed me photographs of two additional large specimens of this ray, which he said had been taken in the same area "during the past two years". In both photos the denticles on the tail, as well as the few enlarged ones of the body, are clearly visible.—CRAIG PHILLIPS, *Miami Seaquarium, Rickenbacker Causeway, Miami, Fla.*

AN OCCURRENCE OF THE PARROTFISH, *SPARISOMA RADIANS*, IN A TEXAS BAY.—A single specimen of the parrotfish, *Sparisoma radians* Cuvier & Valenciennes, was taken on November 14, 1955, in Corpus Christi Bay, Texas. It was collected by shrimp trawl in the intracoastal waterway at marker 16, 5½ miles west of the Aransas Pass, the nearest entrance to the Gulf. So far as can be determined, *S. radians* has not been reported from the Gulf Coast of the United States; though it is reported from the Florida Keys and the Campeche Banks.

This specimen, a male, is 149 mm. standard length (185 mm. total length). The general body color was bluish-green with mottled orange-red dorsal and anal fins which were bluish at their bases. The isthmus was a brilliant yellow; and the cheeks, reddish. The bright bluish-green streak from the eye to the corner of the mouth was immediately bordered in this case with two streaks of orange-red, the lower band being the more brilliant. The caudal fin was uniformly yellowish and lacked the distal black coloration as the males sometimes do. The base of the pectorals was bluish with an orange medial spot. The pectoral base on males is usually black. The pectoral fins were blusish dorsally and had reddish tinges at the centers of their distal edges.

The specimen is in the collection of the Marine Laboratory of the Texas Game and Fish Commission at Rockport, Texas.

The author is grateful to Dr. Loren P. Woods for verification of identification and comparison

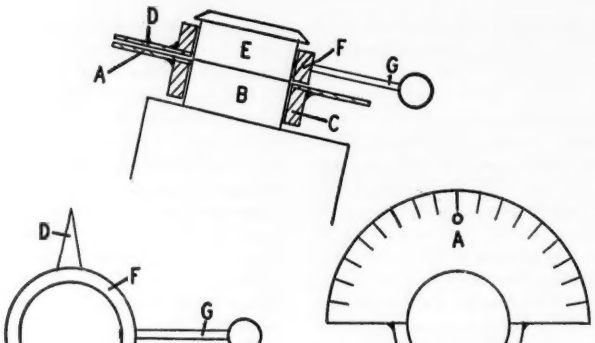

Fig. 1. Diagram of microscope protractor.

with other specimens.—T. R. LEARY, *Marine Laboratory, Texas Game and Fish Commission, Rockport, Texas.*

A SIMPLE MICROSCOPE PROTRACTOR.—In many groups of fishes such angles as those formed by inclination of the mouth, declivity of the snout, etc., are useful taxonomic characters. The accurate measurement of these angles on small specimens is sometimes difficult and it is hoped that the device here illustrated will prove both useful and efficient for this purpose.

The protractor is used with a binocular microscope which has one ocular equipped with cross hairs. Basically the protractor (Fig. 1) consists of a pointer attached to this ocular and a protractor scale attached to the barrel of the microscope. Attachment of the scale (A) to the barrel (B) of the microscope is effected by a sleeve (C) which slips over the barrel. This sleeve can be fitted with a set screw or the barrel can be wrapped with cellophane tape until a snug fit obtains. Similarly, the pointer (D) is attached to the ocular (E) by means of a second sleeve (F). For convenience, a handle (G) is attached to this sleeve. This handle can be made to extend through the sleeve (F) to hold the pointer in place.

To use the device the specimen is placed on the microscope stage with the apex of the angle centered under the cross hairs and with one of the hairs along one arm of the angle. The reading is recorded and then the ocular is rotated until the same cross hair lies along the other arm of the angle to be measured. A second reading is taken and the difference between the two is the angle required. Time can be saved by setting the pointer at 0° before aligning the specimen with one arm under the cross hair, since the second reading will thus give the angle directly and it will not be necessary to subtract the two readings.

The protractor parts can be made of metal or plastic and the dimensions must be varied to fit the microscope on which it is to be used. A satisfactory scale can be constructed by photographing a standard protractor and reducing it to the proper size.—C. LAVETT SMITH, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

FIRST RECORD OF INFESTATION AND DEATH IN THE ICTALURID CATFISH, *SCHILBEODES MIURUS*, BY THE PARASITE *CLINOSTOMUM MARGINATUM*.—On October 15, 1955 three specimens, one male 84 mm. and two females 78 and 75 mm. in standard length, of *Schilbeodes miurus* were collected from Conneaut Creek some two miles southwest of Albion, Crawford County, Pennsylvania. These specimens were transported some 180 miles to this department without any apparent ill affects. The specimens were kept together in a separate aquarium and were fed daily on earthworms. Two small cream-colored nodules were first noticed October 29 on the pectoral fins of the largest specimen. On ensuing days, these nodules increased in size up to 5 mm. and were most pronounced and numerous in the branchiostegal and gular regions of all fish. All three specimens died November 14, within two hours of each other.

Investigation into the nodules revealed 3-4 encysted metacercaria of the "yellow grub" *Clinostomum marginatum*. Since all the internal organs were normal, death was attributed to the *Clinostomum* infestation. The fish had exhibited no outward sign of distress from the infection.

Slides were prepared of these parasites and were sent to Dr. Ralph Bangham for verification. Al-

though he has found this parasite in over 22 species, including such ictalurids as *Ictalurus punctatus*, *Ictalurus catus* and *Ictalurus nebulosus* (Personal letter, Feb. 22, 1956) he has never found it in *Schilbeodes miurus*.

Cort (1913, Trans. Amer. Micro. Soc., 32: 69–182) and Hunter and Hunter (1934, Jour. Parasit., 20: 325 and 1935, Jour. Parasit., 21: 411–412) have worked out the complete life history of *Clinostomum* and find that its intermediate hosts are the great blue heron *Ardea herodias* and the snail *Heliosoma*. The great blue heron has often been seen fishing in Conneaut Creek, where it often flies from its breeding grounds at Lake Erie and Pymatuning Lake, Pennsylvania. Likewise, the snail *Heliosoma* literally abounds in Conneaut Creek. *Clinostomum*, here using a new host *Schilbeodes miurus* as an intermediate, thus has both other elements necessary for the completion of its life cycle readily available.

Thanks are due Michael Dovensky for aid while seining, Patricia Dougherty while preparing slides and Dr. Ralph Bangham for verification of the parasite.—Frank J. Schwartz, *Contribution No. 2, Department of Biology, West Virginia University, Morgantown, West Virginia.*

THE GENUS *LUZONICHTHYS* HERRE, 1936.—In a recent revision of the anthiid fishes of the western Indian Ocean, (Smith, 1955, Ann. Mag. Nat. Hist., ser. 12, 8: 337–350) two new species with divided dorsal fin were assigned to the genus *Naurua* Whitley & Colefax, 1938, whose genotype is *N. waitei* Whitley & Colefax, 1938, from Naurua Island, Pacific Ocean. I expressed the view that *Mirolabrichthys waitei* Fowler, 1931, from the Philippines could not possibly be congeneric with the type species *M. tuka* Herre, 1927, and that Fowler's species might well be put in *Naurua* W. and C.

I have only recently discovered that for *Mirolabrichthys waitei* Fowler, Herre (1936, Philippine Jour. Sci., 59: 366) erected the new genus *Luzonichthys*, which genus however we cannot find either in the Zoological Record or in Neave. Herre's paper (*loc. cit.* above) was unfortunately not seen by me at the time I did my revision (*loc. cit.* p. 345 ff.), and the two new species, *microlepis* and *addisi*, were both assigned to *Naurua* Whitley & Colefax. I pointed out that there were characters, notably scale count and the nature of the scales and of the anal fin, that might well justify separating these two species by full generic rank. I indicated also the close correspondence, on the one hand between *Naurua microlepis* n. sp. and *N. waitei* W. and C., and on the other between *N. addisi* n. sp. and *Mirolabrichthys waitei* Fowler.

Whether or not the members of these two pairs prove to be identical, this appears to be a suitable opportunity to give expression to the difference between the pairs by generic rank, by recognising both *Naurua* and *Luzonichthys*. The known species of this group then become *Luzonichthys waitei* (Fowler), 1931, from the Philippines; *Luzonichthys addisi* (Smith), 1955, from Astove and Aldabra; *Naurua waitei* Whitley & Colefax, 1938, from Naurua, and *Naurua microlepis* Smith, 1955, from Aldabra.

As indicated previously (Smith, *loc. cit.*, p. 345) if all these species are held to fall within a single genus, which would thus be *Luzonichthys* Herre, 1936, it would be necessary to rename the type of Whitley & Colefax, (*Naurua waitei* W. and C.), and in my paper (*loc. cit.*, p. 345) *whitleyi nom. nov.*, is proposed, and under the circumstances here outlined it would become *Luzonichthys whitleyi* (Smith), 1955.—J. L. B. Smith, *Rhodes University, Grahamstown, South Africa.*

DISTINGUISHING CHARACTERS OF THE CYPRINODONT FISHES, *FUNDULUS CINGULATUS* AND *FUNDULUS CHRYSOTUS*.—*Fundulus chrysotus* (Günther) and *Fundulus cingulatus* Valenciennes are small topminnows of the family Cyprinodontidae found in lowland swamps and marshes in southeastern United States. The former seems to be more common in collections and has a wider range. It is found from the Gulf Coast north to South Carolina on the Atlantic Coast and to Missouri and Tennessee in the Mississippi Valley. *Fundulus cingulatus* has been reliably reported only from Florida and nearby areas of Georgia and Alabama. Presumably *cingulatus* has often been mistaken for *chrysotus* since an adequate differentiation between the two has not been made in a key or guide to identification. To correct this deficiency the present study analyzes the variation in the main characters of *cingulatus* and *chrysotus*. Formerly, *Fundulus luciae* (Baird) was also mistaken for *cingulatus* although their ranges are not known to overlap.

I wish to thank Dr. Edward C. Raney, under whom this work was done as part of a review of the genus *Fundulus* submitted as a Master's thesis at Cornell University in 1954.

Dorsal, anal, and pectoral rays were counted at their bases; the last two rays of the dorsal and anal fins were counted as one. (This method of counting dorsal and anal rays differs from that employed by the author in earlier papers.) When left and right pectoral rays were added together the sum was denoted as total pectoral rays. Lateral scales were counted according to the method recommended by Hubbs and Lagler (1947, Cranbrook Inst. Sci. Bull. 26: 11) except that the most anterior scale counted was the one in which the center of the exposed field of the scale lay exactly on, or just posterior to, a

vertical line through the upper extremity of the gill slit. The sum of left and right sides was denoted as total lateral scales. Scales around the caudal peduncle (usually, but not necessarily, the least number) were counted vertically half way between the posterior origins of the dorsal and anal fins and the anterior limits of the upper and lower procurrent caudal rays. Scales above the lateral series were counted in front of the dorsal fin from the first scale above the lateral series of one side, in a vertical row, to and including the last scale above the lateral series of the other side. In case the scale on the midline immediately before the fin was abnormal, the one counted was the first normal anterior scale. Scales around the body were counted in a complete ring around the body half way between the anus and pelvic fin bases and immediately anterior to the dorsal fin. Mandibular pores were expressed either with both sides added together or with left and right sides separated by a dash; they correspond to pores W, X, Y, and Z of Gosline (1949, Occ. Pap. Mus. Zool. Univ. Mich., No. 519: Pl. 2). Head length was measured with dividers from the bony opercle at its most posterior projection to the tip of the snout, with the mouth closed. Snout length was taken on the midline from the tip of the snout to the anterior bony rim of the orbit, with the point of the dividers inserted to the bony interorbital septum. Postorbital head length was measured from the posterior fleshy rim of the orbit to the posterior edge of the bony opercle at a level with the upper base of the pectoral fin. Other measurements were made according to the methods recommended by Hubbs and Lagler (1947, *op. cit.*: 8–15).

The listed material was studied in the Cornell University Fish Collection.

Fundulus cingulatus. Okefinokee Swamp, Georgia: 318, 4039, 653, 8695–8709, 8711–8712, 309, 304, 286–287, 349. Peninsular Florida: 21103, 4049, 4060, 13234, 24469, 24471. Blackwater River, Florida: 16704. Chipola River, Florida: 17737.

Fundulus chrysotus. South Carolina: 15414, 3989. St. John's River, Florida: 4031, 12000, 12001, 12010. Halifax River, Florida: 4078. Kissimmee River, Florida: 10950, 10236, 12427. Miami, Florida: 16047. Tamiami Canal, Florida: 22537, 4064. Estero Bay to Alafia River, Florida: 3998, 6619, 21954, 12726, 12081, 12183, 12389, 10214, 12560, 12447. St. Joseph's Sound, Florida: 12247. Withlacoochee to, Waccasassa rivers, Florida: 12747, 12790, 12096. 12813, 12752, 12696, 12773, 12292, 12314, 12832, Suwannee to Steinhatchee rivers, Florida: 10237, 10213, 2544, 2536, 12340, 12178, 12208, 2522. Additional Florida collections: 23661, 23723, 23937, 23905, 24468, 24470. Louisiana: 21531, 11867.

The forms *cingulatus* and *chrysotus* are valid species which are sympatric in part. Upon close examination no difficulty was had in identifying all specimens despite the fact that all of the meristic and mensural characters considered overlap in their frequency distributions (Tables I–II). The species differ modally in numbers of mandibular pores, dorsal and anal fin rays, scales in the lateral series, scales above the lateral series, and in the number of cross bars on the body. When coloration has been preserved, females of *chrysotus* may be recognized by the light spots on their sides, and females of *cingulatus* by their vertical bars. In males the vertical bars of *cingulatus* are straighter and more numerous than those of *chrysotus*. Occasional individuals of *chrysotus* have irregular black blotches o pigmentation scattered anywhere on the body. I

TABLE I

COMPARISON OF *Fundulus cingulatus* WITH *Fundulus chrysotus*

Character	*cingulatus*	*chrysotus*
Mandibular pores	Usually 3–3	Usually 4–4
Dorsal rays	Usually 7 (6–8)	Usually 8 (7–9)
Anal rays	Usually 9 (9–10)	Usually 10 (9–11)
Lateral scales	Usually 29–30 (28–33)	Usually 31–33 (30–34)
Scales above lateral series	Usually 9 (8–11)	Usually 10–11 (9–12)
Pearl spots on scales of female	Absent	Present, irregularly scattered over sides of body
Vertical bars	Present in both sexes; narrower, straighter, edges more distinct, usually 12 or more	Present in male only; wider, often wavy and irregular, edges often indistinct, usually less than 12
Chin from side view	Deeper and more curved	Less deep and straighter
Snout	More rounded; slightly shorter, 1.6–2.2 in postorbital head length	More pointed; slightly longer, 1.4–1.7 in postorbital head length
Head from side view	Fuller and deeper	More pointed, almost triangular
Slope of the back to the head	Begins farther forward	Begins farther back
Length of depressed anal fin into head in adult males	Usually 0.9–1.1	Usually 1.1–1.4
Size	Smaller, standard length up to 46 mm.	Frequently larger than 46 mm., standard length up to 56 mm.

TABLE II

FIN RAY, SCALE, AND OTHER COUNTS FOR *Fundulus cingulatus* AND *Fundulus chrysotus*

Species	Dorsal Rays					
	6	7	8	9	N	M
cingulatus	2	62	17	—	81	7.19
chrysotus	—	38	250	38	326	8.00

	Anal Rays				
	9	10	11	N	M
cingulatus	73	22	—	95	9.23
chrysotus	21	263	41	325	10.06

	Total Lateral Scales														
	56	57	58	59	60	61	62	63	64	65	66	67	68	N	M
cingulatus	10	0	28	5	34	6	9	3	0	1	—	—	—	96	59.34
chrysotus	—	—	—	—	3	11	34	48	107	37	38	13	2	293	64.00

	Scales above Lateral Series						
	8	9	10	11	12	N	M
cingulatus	2	89	5	1	—	97	9.05
chrysotus	—	7	40	89	1	137	10.61

	Vertical Bars on Body											
	6	7	8	9	10	11	12	13	14	15	N	M
cingulatus	—	—	—	—	—	—	4	1	3	1	9	13.11
chrysotus	4	0	9	8	8	2	0	2	1	—	34	9.12

	Sum of Left and Right Mandibular Pores			
	6	7	8	N
cingulatus	24	1	—	25
chrysotus	—	2	48	50

the coloration has faded the two may often be distinguished quickly by the shape of the head and snout, the lateral aspect of the head of *chrysotus* being more pointed; but practice is necessary. In adult males the longer anal fin of *cingulatus* is often distinctive. A brief diagnosis and a description of coloration in live males of *cingulatus*, together with a fairly complete synonymy, was given by Hubbs (1926, Misc. Publ. Mus. Zool. Univ. Mich., No. 16: 12).

The original description of *cingulatus* gave the numbers of dorsal and anal fin rays as eight and ten respectively (subtract one to compare with numbers in this paper); this study has shown them to be the most frequent for the species (Table II). Jordan and Evermann (1896, Bull. U. S. Nat. Mus., 47 (I): 656) published an apparently incorrect redescription of the type, in which the dorsal and anal rays were given as seven and eight (subtract one). Furthermore, their key and text confused the issue by treating several synonyms of *cingulatus* and *chrysotus* as full species. Although most of the errors were corrected in their addenda (1898, Bull. U. S. Nat. Mus., 47 (3): 2829–2830), the resultant confusion has been considerable. The teeth of the front row in *chrysotus* are of the same size as those of *cingulatus* of equal standard length, not longer. The snout of *cingulatus* is shorter than that of *chrysotus*, not longer.

In comparison with postorbital head length the snout of *cingulatus* averages significantly shorter than that of *chrysotus*. In 21 specimens of both sexes of each species from various parts of their ranges and evenly distributed in the range of standard lengths from 20–49 mm. the ratio of postorbital head length to snout length ranges from 1.6–2.2 (averaging 1.9) in *cingulatus*, and 1.4–1.7 (averaging 1.5) in *chrysotus*.

When depth of body is stepped into standard length, *cingulatus* averages slightly less than *chrysotus*. In samples of 15 of each species over a size range of 28–50 mm. the depth of *cingulatus* averages 3.5 in both sexes, and 3.7 and 3.9 in males and females respectively of *chrysotus*.

The depressed anal fin of *chrysotus* was found to be shorter than the head in samples of eight of each sex, averaging 1.3 (1.1–1.5) times into head length in males and 1.4 (1.2–1.5) in females. In *cingulatus* the sexual dimorphism for this character is more striking; the anal fin is longer than or equal to the head in seven of eight males, averaging 0.9 (0.9–1.1), and shorter in seven females, averaging 1.4 (1.2–1.5). That this difference is one of the relative length of the anal fin rather than that of head length was shown by comparing standard length with both head length and length of the depressed anal fin in the same specimens. The ratio of standard length to head length was found to be virtually

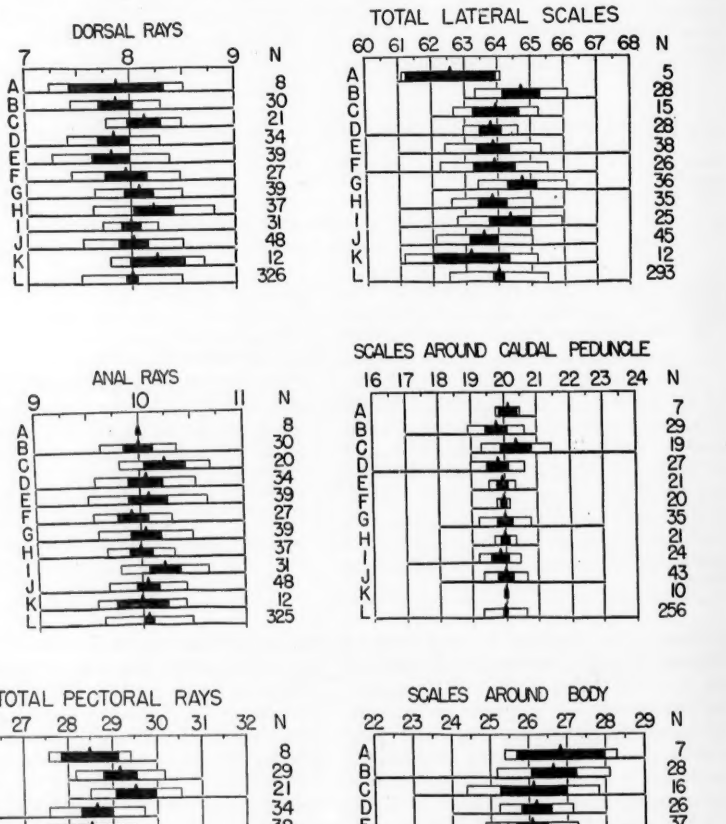

Fig. 1. Geographic variation in six meristic characters of *Fundulus chrysotus*. A, South Carolina; B, St. John's River; C, Halifax River; D, Kissimmee River; E, Miami; F, Tamiami Canal; G, Estero Bay to Alafia River; H, St. Joseph's Sound Drainage; I, Withlacoochee River to Waccasassa River; J, Suwannee River and Steinhatchee River; K, Louisiana; L, Total. For each sample the range is shown as a single, horizontal line; the mean, by a short, pointed, vertical line; one standard deviation on either side of the mean, by a hollow bar; and two standard errors on either side of the mean, by a solid black bar.

identical for the two species although some dimorphism exists between the sexes; it is 3.3 in males and 3.4 in females with a range of 3.1–3.6. The ratio of standard length to anal-fin length in *chrysotus* is 4.1 (3.6–4.5) in males and 4.5 (4.1–4.8) in females; in *cingulatus* it is 3.3 (2.9–3.8) in males and 4.7 (4.3–5.5) in females.

To determine the amount of variation between local populations of *chrysotus* an analysis was made of six meristic characters in over 250 specimens from Florida and in samples of 8 from South Carolina and 12 from Louisiana (Fig. 1). The collections were grouped according to river systems into 11 samples. In the number of dorsal rays, anal rays, and scales around the caudal peduncle none of the sample means is significantly different from the total means. However, in the number of pectoral rays, total lateral scales, and scales around the body at least one sample is significantly different from the total mean although it is a different one in each case. Geographical and local variation in *chrysotus* were found to be relatively unimportant in the material at hand. However, specimens from Texas, Missouri, Tennessee, and Arkansas should be examined. Insufficient material of *cingulatus* was available to permit an analysis of geographic variation, but no indication of it was found in the samples studied.

Fundulus cingulatus is found in lowland swamps and streams from the region of Okefinokee Swamp in southeastern Georgia, south in Florida to the Tamiami Canal (CU 4060) and Fort Myers (CU 13234), and west to the Escambia River, Alabama, where it was recorded by Bailey, Winn, and Smith (1954: Proc. Acad. Nat. Sci. Philadelphia, 106: 132). Their report of its presence in New Jersey was shown by Bailey (*in litt.*) to be erroneous. Records of its occurrence north of Georgia are questionable.

Fundulus chrysotus occurs in lowland swamps and streams from South Carolina (CU 15414, CU 3989) south to Miami (CU 16047) and the Tamiami Canal (CU 22537, CU 4064) of southern Florida, west to eastern Texas, and north in the Mississippi River System to Arkansas, southern Missouri, and Tennessee (no records from Oklahoma) (Hubbs, 1926, op. cit.: 12; Miller, 1955, Occ. Pap. Mus. Zool. Univ. Mich., No. 568: 10).—JERRAM L. BROWN, *Department of Zoology, University of California, Berkeley, California.*

Herpetological Notes

THE GEOGRAPHIC DISTRIBUTION OF THE SUBSPECIES OF *PITUOPHIS CATENIFER* BLAINVILLE IN OREGON.—In his monograph concerning western gopher snakes, Klauber (1947, Bull. Zool. Soc. San Diego, 22: 15) states that in Oregon "there is a broad zone of intergradation between *catenifer* and *deserticola*, and the snakes from this region are difficult to allocate". Since the publication of Klauber's work, new material has accumulated in the collection of the Oregon State College Museum of Natural History from areas where specimens were not available to Klauber. It is now possible to more clearly delimit the ranges of these subspecies in the state and to more precisely determine the areas where they intergrade.

The gopher snakes upon which this report is based were obtained from 17 counties in Oregon as follows: Baker (6), Benton (44), Crook (1), Deschutes (1), Douglas (7), Grant (2), Harney (22), Jackson (5), Jefferson (9), Lake (20), Linn (14), Malheur (5), Polk (1), Union (2), Wallowa (6), Wasco (6), Wheeler (3)—*total* number of specimens, 154. In addition, several specimens of *deserticola* from Idaho and eastern Washington have been available for comparison.

Klauber (op. cit.) has pointed out that no single character may be relied upon to separate these two subspecies. In the present study seven characters in which the two forms have been found to differ were selected as follows:

1. Ratio of tail length to body length. Specimens having a ratio exceeding .15 in males and .14 in females were considered to be *catenifer*. Individuals whose ratios were below these figures were considered to be *deserticola*.

2. Presence of a grey suffusion on the sides of the body and ventral surface of the tail in *catenifer* and the absence of such suffusion in *deserticola*. Although juvenal *catenifer* lack the suffusion, they can generally be told from juvenal *deserticola* by the absence of the black spots usually found on the sides of the ventral surfaces of the tail in the latter.

3. Fusion of the lateral neck blotches with the medial neck blotches in *deserticola* and absence of such fusion in *catenifer*.

4. Higher ventral scale counts in *deserticola*, males having more than 227 ventrals and females having more than 232. Individuals having fewer ventrals were considered *catenifer*.

5. Specimens having total blotch counts exceed-

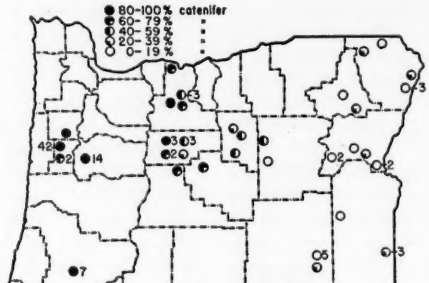

Fig. 1. Integradation between *Pituophis catenifer catenifer* and *P. c. deserticola* in Oregon.

ing 79 were allocated to *catenifer*, those having fewer to *deserticola*.

6. Color of neck blotches—characteristically brown in *catenifer*, black in *deserticola*.

7. Specimens displaying a whitish, yellowish or occasionally blackish ground color were assigned to *deserticola*, those having brown to *catenifer*.

For each of the seven characters each snake was analyzed, and a decision was made as to whether it more closely resembled *deserticola* or *catenifer*, or represented an intermediate condition. Thus a male from Benton County (OSCMNH 1570) resembles *catenifer* with respect to all seven of the above mentioned characters (100 percent *catenifer*). A female from Harney County (OSCMNH 8997) fits *deserticola* throughout (0 percent *catenifer*). In a male from Lake County (OSCMNH 2040) 3, 5, 6 and 7 above fit *deserticola*, 1 and 4 fit *catenifer*, while 2 is intermediate between the two (36 percent *catenifer*). If for some reason a character could not be used as in the case of five specimens with broken tails, the percent was calculated without the use of the particular character involved. Few such cases were encountered. The resulting percentages for all specimens examined have been plotted on the accompanying map.

It should be noted that the method used here has the disadvantage of treating all characters as if they were of equal value. Also, certain points of demarcation separating the subspecies could only be decided arbitrarily. For example a ventral scale count of 227, used to separate males of the two races, represents the midpoint between the means for males of the two subspecies as given by Klauber. Since Klauber states that the probable normal range of ventrals in male *deserticola* is 220–249 it is obvious that 227 will not separate all of them. Also the normal probable range for male *catenifer* is 207–236 so some will no doubt be considered *deserticola* by placing the separation point at 227. Other of the characters were found to overlap in much the same manner within the geographic range of a subspecies. The effect of such variation is minimized by using several characters in combination. In general the ranges of the two subspecies would not be radically different from that shown on the accompanying map were one to utilize only a single character such as the ratio of tail length to body length, ventral scale count or total blotch count; however, a large number of individuals would be located far outside their normal geographic ranges by such a procedure. It seems quite possible that although certain of the characters dealt with in this study are correlated, each may occur as an east-west oriented cline with the areas of sharpest change not necessarily coinciding geographically.

From the data presented here, it appears that the subspecies *catenifer* occupies all of Oregon west of the Cascades and in addition extends east of the Cascades in the northern part of the state via the Columbia River gorge, so that a strong *catenifer* influence is found in Wasco, Jefferson and perhaps Crook and Deschutes counties. It may well be that *catenifer* extends along the entire eastern flanks of the Cascade range in Oregon but we do not have sufficient evidence to substantiate this. It does not seem likely that gene exchange occurs across the Cascades in the area extending from Mount Hood to Crater Lake, the intervening region consisting of an extensive unbroken belt of Boreal life-zones. Fitch (1936, Amer. Midl. Nat., 17: 645) indicates that *P. c. catenifer* was always found below the Canadian Life-zone in the Rogue River Basin and we know of no exception to his findings elsewhere in the Cascade system. In southern Oregon, where the Cascades present a less effective barrier, the *catenifer* influence is quite strong as far east as the Hart Mountain area of Lake County. It now seems that the broad zone of intergradation mentioned by Klauber for the two forms lies wholly east of the

Cascade Mountains, consisting of a belt perhaps 80–100 miles in width and running parallel to these mountains. It is interesting to note that this zone of intergradation occupies an area roughly corresponding to that where overlap occurs if Klauber's map of *deserticola* distribution and Stull's (1940, Bull. U. S. Nat. Mus., 175: 132) map of *catenifer* distribution are superimposed.

During this study it was noted that several gopher snakes representing both sexes from certain counties east of the Cascades quite frequently showed a rather striking salmon-pink ground color on the dorsal surface of the tail and posterior portion of the body. This color has been observed in both living and preserved specimens. Snakes from Grant, Baker, Malheur, Harney, Jefferson and Lake counties displayed such coloration as did a specimen from Payette, Idaho. We have also noted a tendency for *deserticola* from higher elevations in eastern Oregon to possess a much darker ground color than those at drier and lower elevations. For example, those from Wallowa County may have nearly as much dark brown in the ground color as certain *catenifer* from Benton County, whereas *deserticola* from Harney County, particularly those south of the Steens Mountains, rarely show any trace of brown in the ground color.—Denzel E. Ferguson, K. Ellsworth Payne and Robert M. Storm, *Zoology Department, Oregon State College, Corvallis, Oregon.*

CLEMMYS MUHLENBERGI IN WESTERN CONNECTICUT.—Barton and Price, (1955, Copeia (3): 159) state that there is a lack of recent records for the bogturtle, *Clemmys muhlenbergi*, from New England. They hesitated to accept Babcock's (1917) record for an artificial pond in Newport, Rhode Island because of the unusual habitat and the absence of any other New England records for the intervening years.

While examining Connecticut material in the collection of the Yale Peabody Museum, I discovered a specimen of *C. muhlenbergi*, (YPM 2215) collected by Marshal B. Bishop in the entrance tunnel of the long abandoned Roxbury Iron Mine in 1942. This mine is located in Roxbury, Litchfield County, on a hillside overlooking a meadow on the opposite side of the Sheapug River. Between the base of the hill and the river is the characteristic sphagnum bog habitat with which these turtles are generally associated. Careful search of this area has failed to uncover any new specimens.—Douglas C. Robinson, *55 Coniston Ave., Waterbury, Connecticut.*

NOTES ON A LARGE NUMBER OF RED-BELLIED MUDSNAKES, *FARANCIA A. ABACURA*, FROM NORTHCENTRAL FLORIDA.—An unusually large number of juvenal *Farancia a. abacura* Holbrook were collected on the evening of October 19, 1950 by the writers and Mr. E. H. McConkey along U. S. Highway 441 which crosses Payne's Prairie, five miles south of Gainesville, Alachua County, Florida.

The "prairie" is a depressed wet grassland, roughly 20 square miles in area, with a two-mile-long road fill running north and south across its western end. The surface of the highway is about 12 feet above the plain, and paralleling the embankment on each side is a ditch with shallow water, which is choked for the most part with water hyacinths. The area has become famous in herpetological literature as an ideal collecting ground for many species of aquatic and semiaquatic reptiles, although extensive drainage and cattle grazing appear to have reduced its productivity in recent years.

On October 17th and 18th, 1950, a small, but violent hurricane traversed the length of peninsular Florida in a narrow arc from Biscayne Bay to the vicinity of Jasper on the Georgia border. The path of the storm lay about 40 miles east of Gainesville. Although no weather observations were recorded by us at the time of collecting the *Farancia*, published information (1950, Climatological Data Florida, 54 (10): 185–196) indicates that temperatures in Gainesville varied from 69° to 85°F. during the 24-hour period ending at 8:00 AM on October 20th. The same publication reports almost continuous rainfall, amounting to 4.49 inches, during a 70-hour period beginning at 6:00 PM on October 16th and ending at 4:00 PM on October 19th. Our first specimens were collected about four hours after the cessation of the rain. For a week prior to this three day period there was virtually no precipitation (.05 inches on October 9th) in the Gainesville area. It seems very likely that the prolonged period of heavy rainfall which accompanied the hurricane had much to do with the abundance of snakes on the road fill.

The first young *Farancia* were accidentally discovered about 8:30 PM as we stopped to examine a DOR watersnake. It quickly became apparent that *Farancia* were everywhere about us and we decided to walk the entire length of the fill collecting every individual encountered. A total of 478 mudsnakes was thus procured (including one subadult). At least 223 of them were DOR. The snakes were most numerous along the middle 900 yards of the fill and none was found along the northernmost 525 yards. Only 10 to 20 were collected from the western half of the road and its adjacent shoulder; the remainder came from the eastern half and its shoulder and about 12 individuals were found on the eastern slope of the embankment. Other species of reptiles and amphibians taken were as follows: *Storeria dekayi victa* (1), *Natrix sipedon pictiventris* (2),

Natrix cyclopion floridana (2), *Seminatrix p. pygaea* (1) and numerous *Rana grylio*.

Fifty young *Farancia*, chosen at random from among the undamaged specimens, were measured (after several years in preservative) and found to vary in total length from 235 mm. to 292 mm. with an average of 265.7 mm. Umbilical openings were all closed completely, but the scars were plainly visible. Although it is obvious that these specimens represented young of the year, it is questionable whether they were emerging hatchlings. Nine specimens of this species observed by Goldstein (1941, Copeia (1): 49–50) to hatch on October 6–7, 1935, from artificially incubated eggs from the Gainesville area, varied in total length from 182 mm. to 234 mm. with an average of 209.7 mm. Meade (1937, Copeia (1): 12–15; 1046, Sci. Monthly, 63: 21–29) found captive-hatched specimens of the western race, *reinwardti*, to vary in length from 6¼ inches (159 mm.) to 9½ inches (241 mm.) with an average of about 8 inches (203 mm.).

Five of our specimens (3 DOR, 2 LOR), 1.05 percent of the series, were completely lacking in red pigment although they were normal in all other respects. A faint pinkish tinge was noticeable in these specimens when living or freshly killed, probably representing blood in the deeper parts of the skin. At the time of this writing, after more than four years in 10 percent formalin, the pigment-free areas show as a dead white in the three anerythristic specimens preserved. In the remainder of the series much of the original red coloration is retained, and some specimens, in fact, look perfectly natural. The three preserved anerythristic specimens measured 222, 243 and 247 mm. in total length (average 237.3 mm.) and are among the smallest of the series.

There appears to be no mention of anerythrism in *Farancia* in the literature, although we have seen two other such specimens. One is an adult from Payne's Prairie in the possession of Mr. Wilfred T. Neill, Research Division, Ross Allen's Reptile Institute; the other is an unusually large adult female, 1875 mm. long, collected by Mr. David Swindell, also from Payne's Prairie. The latter is University of Florida No. 2450 and its label bears the following color notes made at the time of collection: "No red; all blotches white; labials and chin yellow, gradually fading off at about 10th ventral." This specimen is also aberrant in having a divided internasal plate, characteristic of the related genus *Abastor*. The three anerythristic specimens of our series have the normal undivided internasal, but an examination of 426 additional *Farancia* of this series reveals two specimens with a completely divided internasal and 13 specimens with this plate partly divided.

Mr. Neill states, in correspondence, that he has seen a number of other anerythristic *Farancia* from Payne's Prairie, and that he has collected them in Georgia and South Carolina. He mentions the occurrence of a yellowish "throat patch" in specimens from Payne's Prairie.

Our entire series is now No. 6638 in the collection of the University of Florida.

We wish to thank Dr. James A. Oliver for checking the manuscript prior to our making certain revisions and Messers Walter Auffenberg and Richard Highton for providing us with data on the large *Farancia* in the collection of the University of Florida.—ROBERT E. HELLMAN, *507 E. 76th Street, New York, N. Y.* and SAM R. TELFORD, JR., *University of Virginia, Charlottesville, Virginia.*

AGKISTRODON OR *ANCISTRODON*?—An uncertainty exists as to the proper name for the genus of pit vipers that includes the moccasins, for which the generic name proposed by Beauvois in 1799 is sometimes spelled *Agkistrodon* and sometimes *Ancistrodon*. Although European herpetologists have tended to follow Boulenger (1896, Catalogue of the snakes in the British Museum, 3: 519) in a preference for *Ancistrodon*, their American confreres, until recently, have generally used *Agkistrodon*, as was done by Stejneger and Barbour in the five editions of their "Check List of North American Amphibians and Reptiles", 1917, 1923, 1933, 1939, 1943. A recent reversal of their policy in two important American works (Schmidt, 1953, A check list of North American amphibians and reptiles: 223; Stebbins, 1954, Amphibians and reptiles of western North America: 331, 462) prompts this note, for I believe the change to be improper.

This problem of generic nomenclature involves both a typographical error and one of transliteration, and these two are sometimes confused or merged. It seems to be assumed that if a change is made to correct the typographical error, there is justification for one's going the whole way and correcting the error of transliteration as well. But this procedure, however logical, does not conform to the rules of nomenclature. It has not always been noticed that the author himself corrected the first error in the original publication in which the error was made. This leaves the second error to be considered entirely on its own merits.

It is true that the printer of Beauvois' paper (Beauvois, 1799, Trans. Amer. Philos. Soc., 4: 362–381) did misspell the name in one place, printing it *Agkishodon*. This occurred in a footnote (p. 370) that mentioned the copperhead, there referred to as *Agkishodon mokasen*. We may speculate that Beauvois neglected to cross the *t* in the *tr*, for which reason this pair of letters was thought by the printer to represent *h*. But be that as it may, it is important to note that the printer made no similar mistake when the name reappeared on p. 381, where the new genus was described, and the name was properly

spelled *Agkistrodon*, that is, proper except for a question of transliteration. At any rate the second entry makes it clear that *Agkistrodon* was Beauvois' intention.

No doubt an error of transliteration may be adduced, and *Ancistrodon* is to be deemed more proper than *Agkistrodon* from this viewpoint. I believe that such an emendation was first suggested by Wagler (1830, Natürliches System der Amphibien: 176). Baird (1854, On the serpents of New York: 13) was one of the first Americans to use the revised spelling. The nature of the error of transliteration has been pointed out by Stejneger (1907, U. S. Nat. Mus., Bull., 58: 449), Brown (1954, Composition of scientific words: 22), and others.

The Copenhagen Decisions on Zoological Nomenclature (Hemming, editor, 1953, Copenhagen decisions on zoological nomenclature) are quite specific on the point involved, since they elaborate former Article 19. Errors of transliteration do not invalidate or make possible a change in an author's original spelling (Rule E, 71, 1, a, i, p. 43). The next paragraph of this rule (ii, p. 43) provides that if there are two original spellings, and it is not clear which was intended, the one chosen by the first subsequent user should stand. This is not applicable in the present case since *Agkishodon* has no meaning, whereas *Agkistrodon* is derived from the Greek words for hook and tooth, and was clearly Beauvois' intention, even though it be admitted that the use of *nc* in the place of *gk* might have been preferable. Thus *Agkistrodon* should stand; only by a specific action of the International Commission on Zoological Nomenclature could *Ancistrodon* be adopted, and this would be undesirable since stability would be better served by the retention of Beauvois' spelling.—Laurence M. Klauber, *233 West Juniper Street, San Diego 1, California.*

DISTRIBUTION OF THE MEXICAN MOCCASIN: A CORRECTION.—A correspondent recently asked me for the basis on which the state of Guerrero was included in the geographic range of the Mexican moccasin or cantil, *Agkistrodon bilineatus* Günther, in "A Synopsis of the American Forms of *Agkistrodon*," (Gloyd and Conant, 1943, Chicago Acad. Sci., Bull., 7: 147–170). Investigation revealed that, in this particular, our statement (p. 163) and map (p. 165) are in error through an inadvertency on my part. We have no records of the occurrence of this species in Guerrero.

Our record for Coahuila (*loc. cit.*) was based upon an incorrectly cataloged museum specimen, actually from the vicinity of Linares, Nuevo León, as has been explained by Schmidt and Owens (1944, Field Mus. Nat. Hist., Zool. Ser., 29: 113). This specimen from Linares was recently designated as the paratype of *Agkistrodon bilineatus taylori* Burger and Robertson (1951, Univ. Kansas Sci. Bull., 34: 213).—Howard K. Gloyd, *Chicago Academy of Sciences, Chicago 14 Illinois.*

COMPARATIVE SURVIVAL OF HYBRID TOADS (*B. WOODHOUSEI* X *B. VALLICEPS*) IN NATURE.—The comparative survival of species hybrids and the parent species in natural populations is virtually unknown in animals, yet this information is essential to an understanding of the dynamics of speciation. At least one theory as to the origin of isolation mechanisms (Dobzhansky, 1937, Genetics and the Origin of Species) hinges on differential success of hybrids and parent species.

The experiment reported here was undertaken to test the comparative survival of hybrid toads (♀ *B. woodhousei* x ♂ *B. valliceps*) and the parent species. Thornton (1955, Evolution 9(4): 455–468) has shown that the offspring of the above cross are nearly or completely sterile and only males are viable, while offspring from the reciprocal cross are all inviable.

I am indebted to Wilmot A. Thornton for making available the hybrids and control animals used in this experiment.

This work was done under National Science Foundation Project No. NSF G-328.

The laboratory raised F_1 hybrids and laboratory raised controls were released in a large natural population of *B. valliceps* and a small population of *B. woodhousei*. The releases were made near an artificial pond about 5 miles east of Austin, Texas. A large, established population of *valliceps* breeds regularly in this pond. No *woodhousei* bred in the pond in 1951, but each year since 2 to 4 males and an unknown number of females have used it as a breeding site.

On June 10, 1953, a lot of 50 hybrids, 18 *valliceps* and 8 *woodhousei*, all laboratory raised, were numbered by toe-clipping and released. The hybrids averaged 17.7 mm in snout-vent length and ranged from 13 to 24 mm. The *valliceps* averaged 13.7 mm and ranged from 10 to 20 mm. The *woodhousei* averaged 17.0 mm and ranged from 14 to 19 mm. The toads were released in a dry period. There had been a total of 1.65 inches of rain over a 9-day period ending 27 days before the release. A 0.35-inch shower came 2 days after the release, and there was a rain of 1.24 inches 19 days after the release. The toads were scattered at random about dusk around the margin of the pond and in artificially watered areas of flower beds and lawn.

A second release consisting of 16 hybrids but no controls was made on August 7, 1953. These averaged 19.4 mm in snout-vent length and ranged from 17 to 23 mm. Conditions were unfavorably hot and dry when this release was made, and probably for this reason none of the toads was ever seen again

after being released in the same way as the first batch.

Rainfall in this area has been subnormal for the past five years. The average annual rainfall at Austin is 33.45 inches. In 1953, there was a total rainfall of 29.68 inches, but 11.87 inches of this came in October and December. In 1954, there was a total of only 11.42 inches for the year. Only once during the year (May 25–26) was there rainfall in excess of one inch in any 24-hour period. The first half of 1955 was only slightly deficient in moisture, with 14.77 inches by comparison with the average of 17.45 inches for this period.

Little breeding of the toads was evident in 1954 because of the drought, and I was away and unable to check the population at the one major period of breeding activity (1.68 inches of rain) in May. Nevertheless, 5 hybrids were recorded in 1954, at which time all were sexually mature. These, with 3 others which were recorded in 1955 but not in 1954, indicate that at least 8 (16%) of the 50 hybrids in the first group released survived to sexual maturity. All the hybrids recovered were males, which agrees with the observation of Thornton (*op. cit.*) that only the male hybrids are viable. No control animals were recovered in 1954.

Two periods of intense reproductive activity in 1955 (May 18–20; July 14–15) permitted a more thorough census of the population than in the previous year. Five (10%) of the 50 hybrids originally released were still alive (Table 1), and three (17%) of the *valliceps* controls were also recovered. At this time all these toads were approximately 2 years old and were participating in their second breeding season. None of the 8 *woodhousei* originally released was ever recovered.

TABLE 1

DATE OF MARKING AND DATES OF RECOVERY OF HYBRID AND VALLICEPS TOADS. ENTRIES ARE SNOUT-VENT LENGTHS IN MM.

woodhousei x valliceps hybrids	1953		1954				1955				
	6/10	10/23	6/19	7/31	8/9	8/22	3/5	4/11	4/21	5/20	7/14
♂101	19					84	85			92	93
♂102	21									90	93
♂110	18				83						
♂112	18							97		95	97
♂116	24		91					95		95	98
♂123	22	79						93			
♂124	13		99*							94	95
♂125	19		85								
♂130	18	84									
valliceps											
♂161	12								83		
♂164	15										86
♂166	15									80	83

* Presumed error in measurement.

The body size of the hybrids was more nearly like that of *woodhousei* than of *valliceps* (Table 1). Males of the latter species average less than 80 mm in snout-vent length at one year (Blair, 1953, Copeia (4): 208–212), whereas one male *woodhousei* of which I have a record measured 89 mm at approximately one year. One of the hybrids (No. 130) was approximately as large at the age of 7 months as the 3 *valliceps* control males were at the age of 2 years.

The percentage survival was of the same order of magnitude (10% and 17%, respectively, to age 2 years) in the hybrids and the *valliceps* controls. The survival of both classes was of the same order of magnitude as Blair (*op. cit.*) found in field hatched and metamorphosed *valliceps* marked at approximately the same size in the same locality.

The numbers of animals tested were too few to reveal slight differences in survival success of the 2 types. The results do suggest, however, that the difference is slight if the hybrids do differ from the *valliceps* in the ability to survive in this situation. Because of their small number little significance can be attached to the failure to recover any of the 8 *woodhousei*. Generally less suitability of the local environment for *woodhousei* than for *valliceps* could have been a factor.—W. FRANK BLAIR, *Department of Zoology, University of Texas, Austin, Texas.*

THE IDENTITY OF THE MEXICAN LIZARD, *CNEMIDOPHORUS GADOVI*.—The name *Cnemidophorus gadovi* was proposed by Burger (1950, Chicago Acad. Sci. Nat. Hist. Misc., 65: 2) for a specimen, United States National Museum No. 40042, collected by J. N. Rose at Hermosillo, Sonora, Mexico. This new species was considered most similar to *C. labialis* and *C. inornatus*. Recently Savage (1954, Trans. Kans. Acad. Sci., 57: 329) has shown that the only feature in which *gadovi* was said to differ from *inornatus*, broad contact of the second upper labial and anterior nasal, had been misinterpreted by Burger, and that the anterior nasal and second upper labial scales were not in contact. Since the only supposed difference between the two species was thus disposed of, Savage referred *gadovi* to the synonomy of *inornatus*.

Cnemidophorus inornatus has its center of distribution in the Chihuahuan Desert Region. Although not recorded from Sonora previous to Savage's reference of *gadovi* to *inornatus*, *C. inornatus* was to be expected in the northeastern corner of the state. Its presence there is attested to by several specimens from the vicinity of Cananea collected August 1–16, 1946, by V. Walters, A. Taleporos, P.

Taleporos, and E. Williams (A.M.N.H. 67540, 67542, and seven untagged). The identity of these individuals has been checked by comparison with specimens from Cochise County, Arizona, directly across the border.

However, Hermosillo, the type locality of *gadovi*, is in central Sonora well within the Sonoran Desert. This apparent distributional anomaly led me to examine the type and unique specimen of *gadovi* to check its specific identity. Through the kindness of Dr. Doris M. Cochran and Dr. Remington Kellogg, I was able to receive the specimen on loan and make the necessary examination. The conclusion I have reached is that the lizard represents neither the distinct species *C. gadovi* nor *C. inornatus*, but rather is a young individual of *Cnemidophorus tigris aethiops*, a form that also has Hermosillo as its type locality.

C. gadovi was said by Burger to have the post-antebrachial scales "approximately four times the size of adjacent scales." If this were true, the lizard could not be confused with *C. tigris*, but upon examination of the specimen I find that these scales are very little enlarged, certainly no more so than in *C. tigris*. These scales are markedly larger in *C. inornatus*, in which species they are about three times the size of the smaller scales on the posterior surface of the forearm. Another point of difference between the two species is in the size of the dorsal scales. The scales of *tigris* are smaller and hence more numerous. Scale counts for twenty specimens of *inornatus* from Socorro County, New Mexico (Lowe and Zweifel, 1952, Bull. Chicago Acad. Sci., 9: 243) give a mean of 62.0 ± 0.69 scales around midbody (excepting the enlarged ventrals), range 55–78, and 153.7 ± 2.0 scales occiput to rump, range 141–173. The type of *gadovi* has 88 scales around midbody and 204 occiput to rump, so is well removed from the range of *inornatus*. Juveniles and even small adult females of *C. tigris aethiops* are, as is the type of *gadovi*, striped lizards without a trace of spotting in the dark fields between the light lines. Such individuals, especially as preserved specimens, are difficult to identify unless the appropriate features of scalation are considered.—Richard G. Zweifel, *Department of Amphibians and Reptiles, The American Museum of Natural History, New York.*

FOOD HABITS IN JUVENILE FROGS.—It is generally well known that amphibians, both salientians and urodeles, will learn to respond in a particular way to regular feeding procedures. Newts can be trained to take liver from a pair of forceps, and frogs and toads will sit expectantly in a saucer where meal worms are periodically deposited. It is of interest then to obtain some information on how soon after transformation a frog will be able to adjust to a regular feeding procedure. In our studies on the color pattern genetics of the Pacific treefrog (*Hyla regilla*) we raise a great number of both frogs and *Drosophila*. The tadpoles are raised in two-quart pyrex glass dishes and when they transform are transferred to small aquaria. The *Drosophila* are raised in the usual culture bottles and when the culture is ripe the cotton plug is removed from the bottle and the opening and neck are covered with a small piece of parafilm. The bottles are then placed inside the aquaria in an upright position and the parafilm perforated. Within two days after being placed in the aquaria the juvenile *Hyla* have learned to leap to the top of the bottles and capture the *Drosophila* as they emerge. It is reasonable to assume that this ability of a newly metamorphosed frog would be of distinct advantage in nature where meals tend to recur (an ants nest for example) in the same place daily.—David L. Jameson and Rose M. Myers, *Department of Biology, University of Oregon, Eugene, Oregon.*

RECIPROCAL MIS-MATINGS BETWEEN *HYLA SQUIRELLA* AND *MICROHYLA CAROLINENSIS*.—In many anurans species discrimination and mating preference do not appear to be completely effective isolating mechanisms. It is not unusual to encounter mis-matings between different species of toads, but it is disconcerting to witness amplexus between members of different genera. During the evening of June 28, 1955, a breeding congregation of *Bufo valliceps*, *Bufo fowleri*, *Hyla squirella*, and *Microhyla carolinensis* was in a rain-flooded temporary pool in Audubon Park, New Orleans. The following mated pairs involving *Hyla* and *Microhyla* were found: 24 *Hyla* ♂ x *Hyla* ♀, 37 *Microhyla* ♂ x *Microhyla* ♀, 2 *Hyla* ♂ x *Microhyla* ♀, and 3 *Microhyla* ♂ x *Hyla* ♀. The squirrel tree frog and the narrow-mouthed toad represent not only distinct genera but different families (Hylidae, Microhylidae).

In the laboratory the five mis-mated pairs were placed in separate aquaria containing pond water and vegetation. To ascertain the strength of the mis-matings, several males of the same species as the mis-clasped female were introduced into each aquarium, but their attempts to dislodge the original males were not successful in any of the aquaria. The tenacity of clasping males may reflect their inability to interpret the mating activity of the males of the opposite genus. Moreover, these clasping males did not react evidently to the release stimuli emitted by the mis-clasped females.

Between 4:00 AM and 5:30 AM the following morning, the females, while still engaged by the males, deposited their eggs. Examination of the eggs in each of the aquaria revealed that the foreign sperm had failed to penetrate the eggs. There was no small dark indentation ("the Eispek") on the sur-

face of the animal pole that, if an egg is fertilized, marks the region where the second polar body is released.

Although reciprocal fertilizations between *Hyla squirella* and *Microhyla carolinensis* are impossible, the occasional breakdown of preferential mating reactions does result in a decrease of the biotic potential of each species.—E. PETER VOLPE, *Department of Zoology, Newcomb College of Tulane University, New Orleans, Louisiana.*

REVIEWS AND COMMENTS

DIE REZENTEN SCHILDKRÖTEN, KROKODILE UND BRUCKENESCHEN. By Robert Mertens and Heinz Wermuth. Zoologische Jahrbücher, 1955, Vol. 83, No. 5, pp. 323–440.—The aim of the authors is to bring together the scattered information on the nomenclature, systematic status and geographical distribution of the extant forms of the Testudines, Crocodylia and Rhynchocephalia. The authors recognize 12 families, 66 genera and 211 species of turtles; 3 families, 8 genera and 21 species of crocodylians; and the lonely tuatara. About 65 years ago, Boulenger (1889) recognized 11 families, 48 genera and 201 species of turtles; 1 family, 7 genera and 23 species of crocodylians; and the monotypic Hatteridae (Sphenodontidae). It is significant from the standpoint of the history of the systematics of turtles, that to the 48 generic distinctions admitted by Boulenger, only 4 (*Annanemys, Hieremys, Malacochersus* and *Pseudemydura*) of the additional 18 listed by Mertens and Wermuth are based on species described since the appearance of Boulenger's *Catalogue*. It is also significant that the percentage of monotypic genera has increased disproportionately. Thirty-five per cent of the turtle genera listed by Boulenger were regarded as monotypic, as compared to 58 per cent of those listed by Mertens and Wermuth. That this increase in monotypy, over the years, is the result of enlightened systematic procedure is questionable.

The authors have taken the usual liberties, long regarded as checklist license, in some of their taxonomic arrangements. Some disjunct populations of closely related forms are recognized as parts of a single rassenkreis (e.g., *Chelydra serpentina, Gopherus polyphemus*) and some as separate species (e.g., *Pseudemys scripta, P. callirostris, P. dorbignyi, P. ornata, P. grayi; Terrapene carolina, T. mexicana*) although the evidence for the different conclusions is identical. This sort of differential treatment of systematic categories greatly weakens the device of using the numbers of species and genera characteristic of a given area as a measure of its distinctness or of its faunal richness. Also, it emphasizes the fact that checklist authors would cause less confusion if they would indicate clearly their deviations from the latest "authoritative" references.

Amyda and *Trionyx* swing once more on the nomenclatural pendulum. All American forms are assigned to *Amyda* as are all of the Old World species except *punctatus* (Indian peninsula and Ceylon) which is assigned to *Trionyx*.

The section on the Crocodylia warrants little comment here for it follows the arrangements of the junior author as set forth in his excellent *Systematik der rezenten Krokodile* (1953). Here, obviously, the checklist writer and the specialist are one, and, gratifyingly, any disagreement with his arrangements can be directed toward the reviser and the compiler at the same time.

The authors recognize the three subspecies of *Sphenodon punctatus* proposed by Wettstein.

This checklist is an extremely useful and important work. It is invaluable as a reference. Many of its pages carry the unwritten but definite message that much more research needs to be done on the systematics of turtles.—NORMAN HARTWEG, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

A COLORED ATLAS OF SOME VERTEBRATES OF CEYLON. By P. E. P. Deraniyagala. Government Press, Colombo, Ceylon. Issued in three volumes, 1951–1955. Vol. 1. Ordinary Edition 15.00 rs.; de Luxe Edition 30.00 rs.; vol. 2, 15.00 rs.; vol. 3, ?.

Vol. I (with subtitle "Fishes"). pp. 1–149, 30 colored plates, 60 text figures.

Vol. II (with subtitle, "Tetrapod reptilia") I–XII + 1–101, plates I–IX (black and white), plates 1–35 in color; 44 text figures. Most of the figures on the plates are here published for the first time. The color plates are lively and somewhat impressionistic. The turtles, crocodiles and lizards are

treated taxonomically with keys, descriptions, notes on distribution, variation, etc. Several new names for suborders, subfamilies, genera and subspecies are introduced.

Vol. III (with subtitle, "Serpentoid reptilia") I-XX + 1-121, plates I-VII (black and white), plates 36-49 in color. The serpents are treated taxonomically and keys and descriptions are given. Several new names for suborders and lower categories are introduced with the following comment: "A new system simplifying identification is here employed by greater use of the "subfamily" and restriction of the subgenus. A genus overburdened with numerous species is separated into two or more if it comprises several groups of species which are each separable from the others by its own syndrome of characters. The new classification presents a clearer picture than hitherto of the trend of evolution when those endemic subfamilies are studied in connection with the range of the family to which they belong. . . . It is proposed to discard names of orders and suborders not derived from one of the genera they contain unless there is some cogent reason for their retention."

Concerning the python Mr. Deraniyagala writes: "Its ability to recover from injuries is remarkable, for a 12 foot individual which had its head cleft from snout to nape with a chopper recovered within a month."

He recognizes ten named color varieties of the sea snake *Pelamis platyurus* four of which are known synonyms of *platyurus*, and six are new names given here. Two others are described but not named. He states: "The value of this the most far-ranging sea snake as a current indicator merits special study. The variety *bicolor* is usual throughout its entire range but some of the other color varieties differ sufficiently both in their local abundance and complete absence to indicate the existence of two or three subspecies. The occasional appearance, in Ceylon waters, of certain color varieties that are usually unfamiliar and the fact that they are so exhausted as to be readily captured suggests that they had arrived from some distant area."

A most interesting appendix gives a resume of Sinhala folklore concerning serpents, extracted from ancient palmleaf manuscripts.

Together the latter two volumes of the work offer a useful resume of the Reptilian fauna of Ceylon. While previous works have been utilized, especially Wall's "Ophidia Taprobanica," considerable new information is offered.

The work might have been improved had the text been set in two columns on the page, since a 9½ inch line of print makes for difficult reading.

The author is the versatile Director of the National Museums of Ceylon, and has published widely in archaeology, anthropology, folklore, paleontology, paleobotany, and invertebrate zoology, as well as in the fields of herpetology and ichthyology.—EDWARD H. TAYLOR, *Department of Zoology, University of Kansas, Lawrence, Kansas.*

THE COMPARATIVE ENDOCRINOLOGY OF VERTEBRATES. PART II. THE HORMONAL CONTROL OF WATER AND SALT-ELECTROLYTE METABOLISM IN VERTEBRATES. Edited by I. Chester Jones and P. Eckstein. Cambridge University Press, New York, 1956. 125 pp., 20 figs. $4.75.—This fifth memoir of the Society for Endocrinology is a report of an international conference of endocrinologists. It was the stated intention of the conference to devote the major portion of the papers to a consideration of the mechanisms concerned in the control of water and salt-electrolyte metabolism in vertebrates lower than mammals. The Chairman, Dr. S. J. Folley, emphasized in his opening remarks that life depended upon enzyme-catalysed energy shifts in an aqueous medium and that the evolution of higher vertebrates as they migrated from aquatic to terrestrial habitats depended upon adequate changes in the mechanisms for the control of water and salt metabolism. The Chairman in his closing remarks expressed satisfaction that a comparative approach had been used in the papers which laid the ground work for evolutionary interpretations. Seven papers were given during the conference and each paper was followed by formal and informal discussions by members of the conference. The texts of the papers, bibliographies and the discussions which followed presentation of the papers are printed in full.

The first paper by E. J. Conway on THE FUNDAMENTAL PROBLEMS IN THE HORMONAL CONTROL OF WATER AND SALT-ELECTROLYTE METABOLISM dealt with the mechanisms and their control at the cellular level. Electrolytes and water in plasma and in cells and their passage through cell membranes were discussed and the results of experiments using frog and mammalian muscle, liver and renal slices and yeast cells were cited. The effects of adrenalectomy upon the normal mechanism were summarized as: (1) an increase of K in the plasma leading to an increase in the (muscle) cell, (2) metabolic changes in the non-diffusible constituents of the cell, (3) small losses in the cell of Na compensated for by a net increase of K, (4) insignificant changes in Mg, (5) increases and decreases in certain organic compounds. After administration of different cortical hormones and of certain estrogenic and androgenic compounds to the adrenalectomized animals it was concluded that in replacing the function lost by adrenalectomy certain cortical hormones and testosterone were effective but that the extent of their action was differential.

The second paper by H. Heller on THE HORMONAL CONTROL OF WATER AND SALT ELECTROLYTE METABOLISM WITH SPECIAL REFERENCE TO HIGHER VERTEBRATES was concerned mostly with the hormones of the neurohypophysis. The origin of the hormones, their concentration in the body fluids and the nature of the stimuli which lead to their secretion were discussed from data produced by the author of the paper and other investigators. Both the oxytocic hormone and the anti-diuretic hormone (vaso pressin) are elaborated in the anterior hypothalamus but it has not been determined whether both originate at the same site or whether they may be released independently. The oxytocic hormone is not discussed except incidentally for the anti-diuretic hormone is the one chiefly concerned in water and salt-electrolyte metabolism. After its secretion in the hypothalamus vasopressin is stored in the pars nervosa of the pituitary. Assays of anti-diuretic activity are made preferably upon blood and plasma rather than urine for the reason that kidneys and livers (or rats) transform vasopressin into substances of lower anti-diuretic activity. The kidneys and liver (of rats) are the main sites concerned in the removal of vasopressin. Secretion of vasopressin is promoted by: (1) loss of body water, (2) loss of blood volume, (3) loss of blood pressure, (4) lactation, (5) possibly by stimulation of the sensory fibers of the vagus, (6) pain, excitement, and the effects of certain drugs. The skins of amphibians and the kidneys of some amphibia and of reptiles, birds and mammals are the principal target organs of vasopressin and as shown by water uptake in these organs under the control of the hormone. There may be other undiscovered target organs of vasopressin since a vasopressin principle has been demonstrated in the pituitaries of some animals (fishes) which exhibit no diuretic effect. In the kidneys the anti-diuretic effect is promoted by the absorption of water at a point distal to the proximal tubules.

WATER AND SALT-ELECTROLYTE METABOLISM IN AMPHIBIA was the title of a paper by W. H. Sawyer. The essential facts concerning water and sodium chloride uptake and excretion in amphibia were presented together with a discussion of the factors controlling the metabolism of the two. Lines of comparison were drawn between amphibia and mammals and between different groups of amphibia. In toads and frogs water is taken up by the skin at variable rates but in the water-adapted *Xenopus* there is little uptake. Water is evacuated by evaporation from the skin and excreted by the kidneys. A water balance response in the amphibian skin can be elicited by either the oxytocic or the vasopressor principle in mammalian neurohypophyseal extracts. The responses in the frog, the toad and *Xenopus* are highly differential to the extracts of each other. The author postulates therefore that the concept of a single water balance principle should be given up. Water excretion by the kidneys is dependent upon two mechanisms, glomerular filtration and water absorption in the tubules. The mechanisms operate independently and it is assumed that there are independent controls. Neurohypophyseal extracts of mammals and amphibians have a profound effect upon renal excretion of water in the toad, less effect in the frog and none in *Xenopus*. Recent experiments and observations have shown that water is resorbed from the urinary bladders in Amphibia and that the process is controlled by a neurohypophyseal agent. In Amphibia, sodium ions and chloride ions are taken up through the intact skin and are excreted through the kidneys. The rate of uptake and of excretion is probably controlled by adrenocortical hormones or by ACTH which promotes the production of the regulating hormones.

The results of studies on the transport of water through the isolated frog skin were presented briefly by V. Capraro and M. L. Garampi under the title STUDIES ON THE FROG SKIN. The small osmometer by which data were secured on the passage of water through normal skins and skins treated with posterior pituitary extract is described. The conclusions reached were: (1) posterior-pituitary extracts act by increasing the net transport of water through an electro-osmotic mechanism and, (2) the transport of water through the walls of the kidney tubules is not a comparable process.

THE HORMONAL CONTROL OF WATER AND SALT-ELECTROLYTE METABOLISM IN FISH was the title of a paper by M. Fontaine. This paper and another by D. C. W. Smith entitled THE ROLE OF THE ENDOCRINE ORGANS IN THE SALINITY TOLERANCE OF TROUT were the only ones directed specifically to the problems in fishes. It was stated at the outset in Fontaine's paper that of all of the vertebrate groups the fishes had been studied least by endocrinologists. Fishes as a whole live in salt or fresh water and some are equipped to migrate from one medium to another. Some imbibe water, others do not. Surfaces of exchange for water and salts are more variable in fishes. Gills enter the picture as organs concerned in the uptake and excretion of water and some salts. The intestine functions in excretion as well as the kidney which in some cases is glomerular and in others aglomerular. At least one of the endocrine organs of higher vertebrates (parathyroid) is lacking in teleost fishes. Added to these complications is the fact that some of the endocrine organs in fishes (thyroid and interrenals) cannot be completely removed surgically. Because of the obstacles to fish experiments, hormones from mammals sometimes have been injected into both fishes and Amphibia and conclusions drawn from differential results ob-

tained in the fishes and Amphibia. In a case cited by the author mammalian pitressin was injected into catfishes and frogs. A positive response was elicited in the frog and none in the catfish. The conclusion was drawn that pitressin had no diuretic effect in the fresh water fish. The possible control of water and salt-electrolyte metabolism in fishes by neurohypophyseal principles has been studied by injecting posterior hypophyseal extracts, by hypophysectomy and by observation of the accumulation or exhaustion of secretory granules in the pre-optic nucleus of the hypothalamus of fishes exposed to hypo- and hypertonic water. It is assumed as a result of the experiments that the neurosecretory products are similar in function to those of amphibia and mammals. It has been demonstrated that hypophysectomy, in the eel at least, causes a decline in serum calcium. Migration from salt to fresh water is accompanied by activation of the thyroid and the change from fresh to salt water by a decline in thyroid activity. It is suggested that the regulatory mechanism of salt and water during migration involves an action by the thyroid principle upon the chloride secreting cells of the gills. There are some experimental data on the effects of interrenal and anterior renal hormones, sex hormones and miscellaneous agents but interpretations of their functions in normal physiology are speculative. In his paper on salinity tolerance of trout Smith emphasized that purified growth hormone from the anterior lobe of the pituitary and thyroid preparations affected salinity tolerance but that extracts of the adrenal cortex and posterior pituitary and certain sex hormones and purified ACTH did not.

In the final paper of the series, on THE ROLE OF THE ADRENAL CORTEX IN THE CONTROL OF WATER AND SALT-ELECTROLYTE METABOLISM IN VERTEBRATES I. Chester Jones surveys the literature and presents the results of new experiments. A thorough analysis is presented of the relative controls by principles in the adrenal cortex and the neurohypophysis of shifts of sodium, potassium and water in mammalian experiments. A similar analysis is made of results in four adult types (winter, spawning, post-spawning and summer) of *Rana temporaria*. In the discussion of the effects of cortical hormones in fishes, reptiles and birds it is emphasized that physiological comparisons must be made with extreme caution because of the dearth of data and because of questionable interpretations concerning homologies in the tissues assumed to be homologous in the different groups.

The reviewer cannot but be impressed by the repeated statements of participants in the conference concerning the unequal state of information in the various groups of vertebrates. Some of the following statements, although lifted from their contexts, indicate the situation: "Once we leave the familiar paths of the accustomed mammalian laboratory animals, the literature thins from abundance to scantiness." "Data on the endocrine regulation of hydro-mineral metabolism in fish are few and, in view of our present state of knowledge, a complete exposition of the subject is impossible." "Another class of vertebrates which offers a challenge to those interested in water and salt-electrolyte metabolism are the Reptilia; but we find . . . that the group has largely been ignored." "Little is known about hormones and water and salt-electrolyte metabolism in the group (birds)." "Nothing has yet been published on the function of adrenocortical homologues in cyclostomes and lung fishes, and little on their histology." A beginning has been made in the synthesis of an evolutionary picture for the vertebrates but progress will depend upon new data particularly in the neglected areas. It is emphasized by the editor, I. Chester Jones, that the construction of a sound evolutionary scheme will depend upon correct considerations of tissue homologies in the different vertebrate groups, comparative identity of the secretions of the tissues and qualitative and quantitative changes in target organs and tissues. The conference is to be congratulated for a sound beginning and a frank facing of strategic and difficult problems. —C. L. TURNER, *Department of Biological Sciences, Northwestern University, Evanston, Illinois.*

THE COMPARATIVE ENDOCRINOLOGY OF VERTEBRATES. PART I. THE COMPARATIVE PHYSIOLOGY OF REPRODUCTION AND THE EFFECTS OF SEX HORMONES IN VERTEBRATES. Edited by I. Chester Jones and P. Eckstein. Cambridge University Press, New York, 1955: 253 pps., 28 figs., 10 pls. $8.50.—This fourth memoir of the Society for Endocrinology contains 14 papers given at a symposium held at The University of Liverpool in July, 1954. The material was directed toward a comparative survey of the reproductive processes in vertebrates with special reference to endocrine control of the processes.

In the first paper by W. S. Hoar on reproduction in teleost fishes, after a thorough survey of observational and experimental work, the conclusion is reached that gonadotrophic hormones elaborated in the pituitary are responsible for the onset of maturity and for the control of reproductive cycles. Environmental factors are responsible partially in some instances. None of the pituitary hormones have been chemically isolated. It is indicated that androgens secreted by the interstitial tissue of the testis control development of the secondary sex characters of the male and also that they produce a general elevation in metabolism. It is suggested that a pre-ovulation corpus luteum is the main source of an ovarian hormone which is assumed to be a steroid

estrogen or a progesteron-like compound controlling the development of female sex characters. In viviparous teleosts in which embryos are retained within the follicles of the ovary or in the ovarian cavity there are modifications of the typical reproductive processes of the oviparous fishes. Control of gestation and of parturition may depend upon the pituitary and the thyroid but the factors have not been studied.

A paper by G. J. Van Oordt and P. G. W. J. Van Oordt on regulation of spermatogenesis in the frog is a study of the interrelations of seasonal factors and pituitary hormones upon the progressive stages of spermatogenesis in different species of frogs. A series of experiments involving hypophysectomy, treatment of frogs at different seasons and under different conditions of light and temperature with implants of pituitaries and androgens from other animal sources are cited. The authors came to the conclusion that spermatogenic cycles are initiated and controlled by gonadotrophic hormones from the pituitary but that the sensitivity of the target tissue is an important factor. It was emphasized that sensitivity of the target tissue was influenced strongly by temperature but not by light.

Seasonal reproductive cycles and the interrelation of endocrine and environmental factors controlling reproduction in female amphibia is the general subject reviewed by C. L. Smith. The literature is extensive in this area. It is concluded that the whole reproductive cycle is regulated by the pituitary but that the cycle of acidophil and basophil cells in the pituitary and also the sensitivity of target cells in the ovary can be affected by temperature. The initial stages in germ cell formation may not be dependent upon hypophyseal hormones but maturation of the eggs and ovulation are so controlled. Pituitary hormones control some of the secondary sex characters but the cyclical changes in the oviduct are regulated by ovarian hormones. Presumably the clasping reflex and oviposition are controlled by a neuromuscular rather than an endocrine mechanism. The cite of production of the ovarian hormone has been a matter of controversy but there is strong evidence that it is produced by one of the cellular constituents of a pre-ovulatory corpus luteum. In a consideration of the factors which activate the pituitary in the production of gonadotrophins the theory is advanced that at a critical temperature an adrenergic reaction between the pituitary and the nervous system is responsible. A high level of thyroid hormones in the blood could compensate for a lower temperature.

Normal reproduction in the four classes of reptiles is surveyed by R. Kehl and C. Combescot. Cyclical changes in the ovary and spermary and in the secondary sex characters of males and females are described. The results of experimental work are summarized in the statement that the results are in accord with the general conception of a unified process in the hypophyseal-sexual endocrinology of the vertebrates and that there is an absence of taxonomic specificity in the principal hormones.

A review of the literature on the relation of environmental factors, particularly light, to the seasonal cycles of reproduction in male birds is made by A. J. Marshall. He concludes that "we have no accurate information concerning what external factors initiate the seasonal cycle in the commonest bird." Since it has been demonstrated that hormones from the anterior pituitary are heavily involved in the stimulation of the gonads and that light stimulates the pituitary in experimental animals considerable attention is given to the pathways of stimulation. Deep photoreceptors in the hypothalamus and the transmission of neurosecretory products to the pars distalis of the pituitary by way of a portal vein system was the subject of an exchange of opinions between Dr. J. Benoit and Dr. S. Zuckerman during the discussion.

The first part of a paper by W. R. Breneman on reproduction of female birds is confined to a review of information on the anterior pituitary, the development of the ovary and the secretion of ovarian hormones. Two types of acidophils and two types of basophils can be distinguished in the anterior pituitary. There are marked differences in cell types and number which are associated with different phases of development and reproduction. A follicle stimulating hormone, a luteinizing hormone and prolactin are recognized. The second part deals with a series of experiments on ovarian development and the role of ovarian hormones. Three steroid hormones, an androgen, a folliculoid and a luteoid hormone, are formed by the ovary. Large amounts of androgen and estrogen are released simultaneously. It is postulated that the estrogenic hormone produced by the ovary increases the production of a hormone precursor in the ovary and the androgenic hormone stimulates the release of the precursor. The androgen may stimulate the pituitary to produce a follicle stimulating and maturing hormone.

The final paper in the series which surveys reproduction in the different groups of vertebrates is offered by P. Eckstein and S. Zuckerman under the title REPRODUCTION IN MAMMALS. The paper emphasizes that the broad genetic pattern of an animal's reproduction is controlled genetically but that the ability of the animal to adapt its reproduction physiologically to environmental factors is also genetically controlled. Illustrations of gradations in reproductive processes within circumscribed groups of animals are presented as well as parallel lines of adaptation in taxonomically separated groups. Gradations are pointed out in seasonal and continuous breeders, in monoestrous and polyoestrus

species, in spontaneous ovulation and induced ovulation, in functional and non-functional corpora lutea, in menstruating and non-menstruating species, in time of implantation of the blastocyte and in other features of reproduction. The authors are inclined to defend the classification system of Heape which is based upon similarities of reproductive types in contrast to a scheme which is based upon conventional taxonomic relations. The search for correlation between reproductive types and breeding habits on one hand and bodily features on the other hand sometimes fails to reveal anything of phylogenetic significance in the reproductive types.

The eighth paper on the EVOLUTION OF VIVIPARITY by L. Harrison Mathews considers the question of the origin, evolution and endocrine control of viviparity in all of the vertebrate groups in which it occurs. There is an extended discussion of the paper by E. C. Amoroso. The parallel tendency of each group to pass in the development of oviparity from an oviparous state through an ovoviviparous condition to one of true viviparity is described together with the development of the essential structures for metabolic maintenance in the embryo and toleration of the embryo by the mother. The corpus luteum or a corpus luteum-like structure found in the ovaries of all vertebrates is assumed to play a major part in the evolution of viviparity.

A second group of six papers covers the subject of sex hormones from fishes to mammals. The first by E. Witschi on vertebrate gonadotrophins is restricted in its scope to a consideration of the gonad stimulating hormones derived from the anterior hypophysis of vertebrates in general and from the primate chorion. Three separate pituitary hormones, follicle stimulating hormone, luteinizing hormone and interstitial cell stimulating hormone are recognized as well as a human chorionic gonadotrophin. The controversial question of the separate existence of an interstitial cell stimulating hormone is discussed fully in the light of experimental evidence. Gonadotrophins are proteins which vary in structure from species to species. Rapidity of secretion of hormones, storage of hormones and the importance and function of the luteinizing hormone in lower vertebrates are questions which are given special attention.

The effects of hypophysectomy, implantation of hypophyses, and administration of homologous and heterologous gonadotrophins upon cyclostomes, elasmobranchs and teleost fishes are reviewed by J. M. Dodd. Secondary sexual characters are found to be controlled by steroid hormones elaborated in the gonads. It is stressed that wider knowledge of the basic physiology of a large number of different fishes is required and that purified extracts of the gonads and the pituitaries used in key experiments are needed before evolutionary trends can be discovered. In the species studied the basic relations between pituitary, gonad and the sexual characters found in higher vertebrates are apparent.

A paper by L. Gallien is concerned with the action of sex hormones on the development of sex in anurans and urodeles. Determination of sex, sex reversal and the control of secondary sex characters are discussed in experiments involving parabiosis, castration, implantation of gonads and the administration of purified estrogens and androgens. Although there are some paradoxial results the experimental data justify the following conclusions: In an early indifferent stage the cortex and the medulla of the gonad are in a state of balance and the soma is bipotential and undifferentiated. Wolffian ducts are laid down during this period of indifference. The medulla or the cortex becomes predominant and the indifferent gonad becomes developed into an ovary or a spermary. In the early stages sex can be reversed but after the gonads have become differentiated sex cannot be reversed. Hormones developed by the ovary and spermary control the development of the appropriate secondary sexual characters.

THE VARYING EFFECTS OF SEX HORMONES IN BIRDS is the title of a paper by R. M. Fraps which deals almost exclusively with control of the process of ovulation. It is pointed out that in the spontaneously ovulating mammal oestrogen is assumed to stimulate the production by the pituitary of luteinizing hormone in quantities sufficient for ovulation It is suggested that in the spontaneously ovulating hen the ovarian hormone progestin may serve to stimulate the pituitary to elaborate a lutenizing hormone. Experimental evidence supports an hypothesis which assumes that progesterone or a physiologically equivalent progestin is produced in the follicle cells of the follicle next due to ovulate and that, through a neuro-humoral mechanism the progestin stimulates the pituitary to release an ovulation inducing hormone. Secretion of progestin by the ovarian follicle is promoted by the sudden release of a luteinizing hormone, possibly augmented by follicle stimulating hormone, from the pituitary.

J. H. Leathem and R. C. Wolf develop literally the topic "VARYING EFFECTS OF SEX HORMONES IN MAMMALS". There is little attempt to synthesize an evolutionary scheme from the data and a reader is impressed with the difficulties of trying to fit endocrine reactions into a system which will conform to conventional taxonomic arrangements. Species and size differences are emphasized in testis and ovarian content and reactions to androgen and estrogen treatment in the gonads and accessory sexual structures.

Attention is focused in a paper by A. Jost on gonadal hormones of the foetus and the effects of the injection of chemical sex hormones on the growing foetus. Key experiments are cited and an excel-

lent summary is provided. During foetal life the laying down of the sexual structures for the remainder of life occurs under endocrine control. A special sensitivity of the developing organs to hormone stimulation changes in late life when the organs are brought into physiological activity. Because of the changes in reaction to hormones at different stages the physiological age of the foetus should be defined exactly in experimental work.

The material presented in the various papers is ably summarized and corelated by Professor S. Zuckerman. He indicates that one who attempts to establish evolutionary trends in the reproduction of vertebrates is presented with large gaps in information, particularly in the reptiles, fishes and lower chordates. Generalizations regarding the control of the processes of reproduction in the various groups of vertebrates are difficult because of the lack of information on the physiology in many animals. Species differences in reactions are encountered continually in experimental work and the need of purified extracts of pituitaries, gonads and other organs in representative forms of each vertebrate group is apparent. The question of the type and sensitivity of target tissues needs to be considered in setting up any evolutionary scheme based upon reproduction. Sensitivity may change with age, physiological condition, variations in environmental stimuli, seasonal conditions, etc. It will be difficult to decide whether certain evolutionary changes come about because of changes in the character of hormones or in the reactivity of the target substrate. The comparative studies single out the pituitaries and the gonads as the nearest approaches to constants but differences in structure and physiology from group to group also are conspicuous.—C. L. TURNER, *Department of Biological Sciences, Northwestern University, Evanton, Illinois.*

THE ANATOMY OF THE HEAD OF *CTENOSAURA PECTINATA*. By Thomas M. Oelrich. Miscellaneous Publications Museum of Zoology, University of Michigan, No. 94, 122 pp. 59 figs.—American herpetologists in recent years have tended to produce works dealing with external morphology and variational studies on the racial level. Anatomy particularly of a descriptive nature, has been neglected although there is an urgent need for such studies, especially since anatomy is the proper basis of phylogenetic studies. There are numerous papers, particularly in German, dealing with the detailed anatomy of a particular system, parts of systems or phylogeny of a single structure. However there are few comprehensive studies concerned with any segment or entire region of the body. At last we have such a study.

This thorough macroscopic head anatomy of *Ctenosaura* includes all systems except the gross anatomy of the brain and eye. This paper will certainly prove to be one of the major starting points for future investigations of lacertilian anatomy. Effective criticism of this paper is difficult without personal examination of material. However, cursory examination reveals several criticisms. Our primary and most serious objection is that the author has used a modified muscle nomenclature and has not consistently offered a synonymy. In some of the muscles checked there is disagreement in nomenclature between Oelrich, Camp, Lakjer, Olsen, etc. As a result we found such incongruent mixtures as a mylohyoid nerve but no mylohyoid muscle. We were disappointed in finding a minimum of comparisons with other well-known forms. Dr. Oelrich has also missed some of the recent pertinent studies of Drs. Poglayen-Neuwall. The illustrations are too few and at times inadequate and confusing. For example we found it difficult to compare the diagrams in Olsen (1936) with those of Oelrich (fig. 42). There appears to be a disagreement in the nomenclature of two of the neck muscles, *M. longissimus cervicus* and *M. longissimus capitis*. Cross sectional diagrams would have aided materially in the interpretation of the descriptions. Paleoherpetologists will feel the lack of diagrams illustrating muscle scars and muscle areas on bone. Certainly Oelrich, as a practicing paleontologist, should have appreciated this need.

In conclusion we feel that this study is a landmark for American herpetology. It will give much needed impetus to the anatomical studies of the Sauria. We look forward to seeing more studies of this type.—MAX K. HECHT, *Dept. of Biology, Queens College Flushing, N. Y. and* JOHN H. OSTROM, *Dept. of Geology, Beloit College, Beloit, Wisconsin.*

LA ECONOMÍA DEL MAR Y SUS RELACIONES CON LA ALIMENTACIÓN DE LA HUMANIDAD. By Zaharia Popovici and Victor Angelescu. Instituto Nacional de Investigación de las Ciencias Naturales y Museo Argentino de Ciencia Naturales "Bernardoin Rivadavia". Publ. de extensión cultural y didáctica, No. 8: vol. 1, i–xiv, 1–659; vol. 2, i–xi, 660–1056; 55 figs., 12 pls., 7 maps. (In Spanish).—The increasing importance of the sea and its products in the economy of man, and the recent strides in all phases of marine research have led the authors to prepare a review of these subjects. Their review is intended to give the layman a better understanding of the field and its many complexities, and to provide basic information for the interested student. Its value as a reference for the specialist is secondary.

Two parts, the bioeconomy of the sea (the sea as a medium of life and production) and the resources of the sea in the economy of man, comprise the first

volume. Part III (problems of the economy of the sea and its relation to human nutrition) and an appendix are included in volume two.

Part I (pp. 13–380) could well suffice as a preliminary text in marine ecology. The properties of water, submarine topography, geographical areas, forms of water movement, fertility, plancton, food chains, regional mass mortality, fluctuations in abundance of organisms, ecological systems and evolution are but a few of the topics discussed. In accordance with the intent of the book, mathematical formulas and physical data are omitted. Oceanographic gear is likewise avoided but here some description would be of interest.

Statistics for various world fisheries emphasize the tremendous importance of one aspect of marine resources and introduce part II (pp. 381–610). Next the actual contribution of each group of animals is discussed. The more important groups of fishes (e.g., the Gadidae, Clupeidae, Heterosomata) are examined individually and here the outstanding species are illustrated and their ranges defined. The nomenclature seems up-to-date throughout. Molluscs, crustaceans, marine mammals, reptiles, echinoderms, sponges and coelenterates are similarly treated, the last four less exhaustively. Algae, eel grass, guano deposits, and inorganic salts are other resources considered here. The section is completed with a chapter on the exploitation of the sea and the industry of marine products. Vessels, gear, types of industry (oils, scale extracts, etc.), local problems and geographical centers for various industries are included.

A chapter entitled "the present world dilemma" introduces part III by discussing past and future world populations and raising questions whose answers provide the framework for the later chapters. Fertility of the sea vs. that of the land, photosynthesis, transplantation of organisms, and latent marine resources are treated. Consideration is given to overfishing and conservation of resources. The last is perhaps best exemplified by the whaling industry. The authors then call on science to provide leadership in conservation. General principles for rational exploitation are given and the actual or potential roles of organizations such as F.A.O., the International Fishery Commission and regional councils are discussed. This leads to the consideration of the role of scientific research but unfortunately the chain of thought is interrupted by a chapter on the present development of marine fisheries and the problem of modernizing the fishing fleet to keep pace with recent advances in technology, discussions which best belong to part II. In a book that discusses most topics fully, it is disappointing to find so few pages devoted to the role of science particularly in view of the book's intended appeal to the layman. Only eight centers for marine research are mentioned. A more detailed account of the research program and personnel of any one station would be more helpful than a limited generalized list of the types of problems studied.

The final chapter of the text considers the important and touchy subject of geopolitics and marine resources.

It is puzzling to find a technical appendix (pp. 887–971) on the chemical composition of marine products in the fresh and commercial (or industrial) state. With thirty-two pages of tables and a literature citation for each entry, and a general discussion of the field, the appendix will likely be the section most used by the professional biologist.

All literature citations are grouped in an inclusive bibliography of 2154 titles. Indices are provided for subject and scientific names. No glossary is given.

The authors have done a fine job of preparing the text. Although published in Argentina it is worldwide in scope; local examples do not seem excessive. That most of it offers little to the English-speaking student should not be considered a shortcoming of the work. For all who read Spanish it provides a most readible and complete review, as non-technical as permissible. The bibliography and the appendix are of value to all. More attention should have been devoted to the illustrations, especially important in a semipopular work. The plates and text figures, of high quality in reproduction, are too few and many might be profitably replaced with figures of more pertinent subjects. A few maps to accompany the discussion of geographical features of the ocean basins, the ocean currents, and temperature distributions are especially needed. However, the work must stand as an outstanding contribution in Spanish to marine biology.—C. RICHARD ROBINS, *3300 North Third Street, Harrisburg, Pennsylvania.*

LIMNOLOGY AND OCEANOGRAPHY. Published quarterly by the American Society of Limnology and Oceanography.—A new journal, of which two issues have appeared, established to serve "as a common outlet for the publication of scientific papers on all aspects—physical, chemical, geological and biological—of the phenomena exhibited by natural bodies of water".

VERGLEICHENDE ANATOMIE UND MORPHOLOGIE DER WIRBELTIERE. By W. Marinelli and A. Strenger. Franz Deuticke, Vienna, 1954.—This work is being published in leaflets, each dealing with a separate animal. The first (80 pp., 65 figs., price about $7) takes up the (adult) lamprey *Lampetra fluviatilis*. Others, of which one more has already appeared, will be devoted to *Myxine glutinosa, Squalus acanthias, Acipenser ruthenus Lucioperca sandra, Salamandra maculosa, Bufo*

marinus, *Testudo graeca* (and *T. ibera*), *Varanus griseus*, and *Phyton* (sic) sp. (along with *Crocodilus niloticus* and *Alligator mississipiensis*) among the cold blooded vertebrates.

HANDBOOK OF TROPICAL AQUARIUM FISHES. By Herbert R. Axelrod and Leonard P. Schultz. McGraw-Hill, New York, 1955: xii + 718, illus.

EDITORIAL NOTES AND NEWS

SUMMARY OF 1956 MEETING

THE thirty-sixth annual meeting of the ASIH was held at the Conservation Training School, Higgins Lake Michigan, June 20–24, 1956. The surroundings were extremely pleasant, leading to considerable conviviality, and the weather was almost ideal. Hosts for the meeting were the Michigan Department of Conservation, the U. S. Fish & Wildlife Service, and the University of Michigan.

EVENTS OF WEDNESDAY, JUNE 20

Many members were met in Ann Arbor and driven to the Training School by personnel of the local committee. At 4:30, the Local Committee arranged a cocktail party for those present.

The meeting of the Board of Governors was called to order by President EDWARD C. RANEY at 8:00 p.m. 28 Governors were present. The following were elected to fill vacancies in the Board. Class of 1961: W. F. BLAIR, ROGER CONANT, HENRY FITCH, W. J. RIEMER, J. R. BAILEY, MILTON TRAUTMAN, JAMES BOHLKE, VADIM VLADYKOV, EARL HERALD, and J. C. BRIGGS; Class of 1959: E. H. TAYLOR and H. K. GLOYD; and Class of 1960: GEORGE MOORE, RICHARD SNYDER, and BOYD WALKER.

The two vacancies among our foreign ichthyological members were filled by the election of KIYOMATSU MATSUBARA of Japan (nominated by CARL HUBBS) and A. N. SVETIOVIDOV of Russia (nominated by LOREN WOODS).

The minutes of the 1955 meeting were approved as published in COPEIA, 1955 (4): 314–323.

ROGER CONANT, Vice-president for Conservation, gave a brief report of his activities which were later presented at the Business Meeting in more detail. FRANK BLAIR, Vice-president for Membership, described his efforts in trying to promote more subscriptions to COPEIA in several southwestern states.

FRED R. CAGLE, Editor-in-Chief, sent to the Board a written detailed summary of the first half-year of his activities. Because of the fact that the budget allowed for 1956 COPEIA is but $5940 (computed as 76% of the 1955 income from dues and subscriptions) and because of the further fact that the editors already have on hand from previous editors a tremendous accumulation of galleys and manuscripts, DR. CAGLE requested that the Board raise the 1956 budget of COPEIA by $1500. FRANCES CLARK moved, and it was passed, that the expenditure for COPEIA for 1956 be increased to $7440.

After considerable discussion it was decided that one or more of the following three procedures would be pursued to obtain the $1500 necessary to carry out the purposes of DR. CLARK's motion.

1. The Editor-in-Chief be chairman of a committee of his own choosing to approach the National Science Foundation for an emergency grant.

2. The Secretary mail a plea to members asking for contributions for this purpose.

3. Anticipated surplus of $900 during fiscal 1956 be used for this purpose instead of increasing endowment as originally planned.

A proposal by the Editor-in-Chief of a redistribution of the duties of the sectional editors was thoroughly discussed. A motion made by ROGER CONANT resulted in the Board reaffirming present policy of leaving authority for acceptance and rejection of manuscripts in the hands of the sectional editors. It was recognized that this might frequently result in long delays between acceptance and publication of a manuscript.

During the discussion of finances, the matter of the association of the ASIH with the AIBS was reconsidered. There was considerable feeling that this association should be reviewed in the light of the five years of existence of the AIBS and a survey of its tangible aid to the ASIH and biologists in general. It was felt that any change in present membership should depend upon the wishes of the total membership of the ASIH since it was the result of a poll of the membership several years ago that provided for our present association. The Board authorized the President, upon a motion by the Secretary, to appoint a special committee to conduct

the poll of the membership. To serve as a guide to the Board's thinking, J. R. BAILEY moved that the Board of Governors recommend to the members of the ASIH that the Society change its association with the AIBS from "membership" to "affiliation." This motion was carried. Membership involves the annual payment of dues to AIBS of one dollar per member of ASIH; the seating of a representative of the ASIH on the Board of Directors of the AIBS; and the receipt by the ASIH members of the *Bulletin of the AIBS*. Affiliation requires the annual payment of a flat fee of $100 with no representation on the Board and no subscription fo the *Bulletin*.

The report of the Treasurer, which was published in COPEIA, 1956 (2): 139–40, was approved by the Board. A statement prepared by JOHN D. KILBY, JOHN C. BRIGGS, and ARCHIE CARR was read, as follows: "The auditing committee has examined the books of the Treasurer of the Society, DR. COLEMAN J. GOIN, and found them satisfactory and correct for the calendar year 1955."

Similar approval greeted the reports of the Publications' Secretary and the Secretary.

Discussion of the matter of finances and the Secretary's report emphasized the fact that publication costs have been rising far more sharply than Society income and that a far more realistic dues schedule must be instituted if COPEIA is to continue at approximately its present size. To produce sufficient income, GERALD COOPER proposed a new dues schedule. The following schedule, to take effect for the calendar year 1957, was approved by the Governors:

Foreign and student members: $6.00 annually
Regular members: $8.00 annually
Subscribers (institutional): $9.00 annually
Sustaining members: $25.00 annually
Life members: $150.00 single payment
Patrons: $1000.00 single payment

Enabling action to effect this new schedule was required and the Board approved the following Constitutional Amendment, that:

Article III: Membership, Section 2 be amended to read as follows:

"Section 2. The membership of the Society shall consist of the following classes:

a. Active Members who pay annual dues in the following categories: Student, Foreign, Regular, Subscriber, and Sustaining.
b. Active Members who make a single payment in the following categories: Life and Patron.
c. Honorary Foreign Members shall be chosen from among the ichthyologists and herpetologists, located outside of the United States, who have attained distinction as investigators. The Honorary Foreign Members shall be equally divided between ichthyologists and herpetologists.

A proposal by HOBART SMITH regarding the recording of certain herpetological data was discussed by the Governors. J. R. BAILEY led the discussion and suggested that before any action be taken that DR. SMITH poll the members of the Society to determine whether a substantial number would be willing to contribute to the program.

It was moved by ROGER CONANT, and passed by the Governors, that an early issue of COPEIA be designated the EMMETT REID DUNN MEMORIAL NUMBER and that the details be left to the discretion of the Editors. The concensus was that the lead article be written by a close associate of DR. DUNN's describing the highlights of his career.

Following an annual custom of long standing, ROBERT R. MILLER moved that the Society contribute 40 pounds towards the publication costs of the ZOOLOGICAL RECORD. The motion was passed.

The Secretary gave a brief report of the annual meeting of the National Research Council of which he has been serving as the Society's representative. He also told of a bill before Congress that would eliminate tariff restrictions on the importation of glass jars for use in collections of preserved scientific specimens.

The final business of the Board was to consider annual meetings sites for the next few years. The invitation of the Department of Zoology of Tulane University to meet in New Orleans during April of 1957 was accepted with appreciation. The 1958 meeting is presently planned for Washington at the Smithsonian Institution during December. At this time the Society will be joining with other biological societies to celebrate the Linneaus bicentennial. It was tentatively planned to meet at the Carnegie Museum in Pittsburgh during 1959.

The meeting was adjourned at 11:30 p.m.

EVENTS OF THURSDAY, JUNE 21

At 10:00 a.m. most of the 92 registered members assembled for the first session at which REEVE M. BAILEY, Chairman of the Local Committee, presided. The following papers were heard.

The Conservation Training School. Edward M. Ray, Superintendent.
Address of Welcome. Justin Leonard, Michigan Department of Conservation
Presidential Address: The Atlantic States Cooperative Striped Bass Program. Edward C. Raney.

Before lunch a group photograph was taken. At this time, many members were delighted with a local edition of DOPEIA. The editors were not readily identifiable. Additional copies of this completely charming and thoroughly insignificant contribution to the literature of cold-blooded vertebrates may be obtained from the Publications' Secretary, N. BAYARD GREEN, for 25¢ each.

After lunch, the meetings were split into two sections. ROGER CONANT presided over the Herpetological Section at which the following papers were given.

Observations of the Mating Habits of the Corn Snake (*Elaphe g. guttata*). James A. MacMahon, Dayton Museum of Natural History.

Correlating Costal Grooves with Trunk Vertebrae in Salamanders. Richard Highton, University of Florida.

Morphology and Seasonal Development of Sex Characters in Two Sympatric African Toads. Bernard Greenberg, Roosevelt University, and Robert F. Inger, Chicago Natural History Museum. Presented by Bernard Greenberg.

Closure of the Nostrils in the Atlantic Loggerhead and Other Sea Turtles. Warren F. Walker, Jr., Oberlin College.

Growth of Larval Amphibia. D. L. Jameson and Bryan B. Vallet, University of Oregon. Presented by D. L. Jameson.

Notes on Distribution and Derivation of the Herpetofauna in the Big Bend Region of Texas. Sherman A. Minton, Jr., Indiana University Medical Center.

Some Observations on Snake Populations. W. D. Klimstra, Cooperative Wildlife Reserve, Southern Illinois University.

The Reproduction of the King Cobra, *Ophiophagus hannah*. James A. Oliver, New York Zoological Society.

The Ichthyological Section, presided over by WILLIAM A. GOSLINE, heard these papers.

An Early Review Article on the Swim Bladder. Edward M. Nelson, Loyola University.

A Study of Hybridization between *Chrosomus eos* and *Chrosomus neogaeus* in New York. John G. New, Cornell University.

Remarks on the Osteology of American Salmonidae. Vadim D. Vladykov, Department des Pecheries, Quebec.

Fecundity Variability of Southwestern Darters. Clark Hubbs, University of Texas.

Brain Pattern and Some Aspects of Behavior in the Amblyopsidae. Thomas L. Poulson, Cornell University.

A Preliminary Study of the Fish Populations of the Small-generator Draft Tubes in Denison Dam, Lake Texoma. Carl D. Riggs, University of Oklahoma. Read by Reeve M. Bailey.

A Taxonomic Study of the Cyprinid Fish, *Clinostomus vandoisulus* (Valenciennes) in the Eastern United States. Earl E. Deubler, Jr., University of North Carolina.

The Relationships of the Fish Fauna of the Revillagigedo Islands, Mexico. Richard H. Rosenblatt, University of California at Los Angeles.

The Relationships of *Tomeurus*, an Egg-laying Cyprinodont, to the Viviparous Poeciliids. Donn Eric Rosen, New York Zoological Society.

Dinner was followed by excellent motion pictures shown through the courtesy of the Michigan Department of Conservation, the New York Zoological Society, and the California Academy of Sciences. For many, the day's activities were concluded at a very delightful smoker where informal discussion ranged considerably beyond the limits of lampreys on the one hand and crotalid snakes on the other.

EVENTS OF FRIDAY, JUNE 22

The Society again met in separate sections. The following papers were heard in the Herpetological Section presided over by W. FRANK BLAIR.

A Distributional Summary of the Herpetofauna of Indiana and Illinois. Philip W. Smith, Illinois State Natural History Survey, and Sherman A. Minton, Jr., Indiana University Medical Center. Presented by Sherman A. Minton.

Dominance of *Mabuya* in the Scincidae. Edward H. Taylor, University of Kansas.

The Ecological Separation of Some Cuban Lizards. Bruce B. Collette, Cornell University.

Intraspecific Variation in the Iguanid Lizard, *Leiocephalus carinatus*. George B. Rabb, University of Michigan.

Development of *Eleutherodactylus latrans*. Bryan B. Vallet and D. L. Jameson, University of Oregon. Presented by D. L. Jameson.

The Inheritance of Vertebral Stripe Color in the Cricketfrog, *Acris gryllus*. William F. Pyburn, University of Texas.

Differential Growth and Estimation of Size in Turtles. James E. Mosimann, University of Montreal.

The Relationships of the Salamanders of the Genus *Plethodon*. Richard Highton, University of Florida.

The Ichthyological Section consisted of a Symposium on Aquaria which was under the Chairmanship of L. C. FINNERAN. It consisted of the following contributions.

Maintenance Mechanics. Christopher W. Coates, New York Aquarium.

A Filtering System for Individual Tanks. William E. Kelley, Cleveland Museum of Natural History.

A Portable Diatomaceous Filter for Aquarium Use. L. C. Finneran, Belle Isle Aquarium, Detroit.

Transportation Water. Leonard N. Allison, Michigan Conservation Department.

Artificial Sea-water. James R. Skelley, Cleveland Aquarium.

Natural Sea-water in a Closed System, with Special Reference to Refrigeration for Octopi. Earl S. Herald, Steinhart Aquarium, California Academy of Sciences.

The Proposed Milwaukee Aquarium. Leonard F. Pampel, Milwaukee Co. Park Commission.

After lunch, some members attended various committee meetings but most went on a number of field excursions to visit interesting areas in the vicinity.

Refreshments were served on the beach at 5:30 and members reconvened at the Dining Hall for a Fish-Fry which was held in lieu of the annual banquet. The featured food was delicious Lake Trout and, realizing its near extinction in several of the Great Lakes, we felt almost as privileged as if we were consuming filet mignons from a *Tyrannosaurus*. Later in the evening we were treated to a most informative discussion by JAMES W. MOFFETT, of the U. S. Fish and Wildlife Service, about the Sea Lamprey in the Great Lakes and its near extinction of the Lake Trout fishery. Motion pictures helped illustrate conservation methods that were being attempted.

EVENTS OF SATURDAY, JUNE 23

Final sessions were held in the morning. The Society met jointly with CHARLES M. BOGERT presiding. The following papers were offered.

Sexual Dimorphism in the Teeth of Agamid Lizards. Bernard Greenberg, Roosevelt University.

Some Social Behavior Patterns in the Lizard, *Agama mutabilis*. Bernard Greenberg, Roosevelt University.

A Note Concerning an Occurrence of a Free-living Cyclopia. Edward M. Nelson, Loyola University.

Some Zoogeographic Problems Involving the Savanna Corridor of South America. Joseph R. Bailey, Duke University.

Regional Endemism in the Fish Fauna of the Colorado River and its Significance in the History of the Drainage. Robert H. Miller, University of Michigan.

Differentiation of Mating Call and Natural Hybridization in Toads (Genus *Bufo*). W. Frank Blair, University of Texas.

At the conclusion of the presentation of papers, PRESIDENT EDWARD C. RANEY convened the members into a business session.

The Secretary gave a report of the meeting of the Board of Governors, essentially as outlined above.

He also moved that the Constitutional Amendment relating to classes of members that was adopted by the Board of Governors, be approved by the membership. The Amendment was approved.

The FREDERICK H. STOYE Awards for the best student papers for 1956 were presented as follows:

First prize, Ichthyology: DONN ERIC ROSEN

Second prize, Ichthyology: RICHARD H. ROSENBLATT

First prize, Herpetology: BRUCE B. COLLETTE

ROGER CONANT, serving as Vice-Chairman for Conservation, reported as follows:

"No specific request for action to protect any fish, amphibian, or reptile was received from anyone during the term of office of the present incumbent.

"An investigation was undertaken, however, that consisted of writing to the game and fish department of each of the many states and territories of the United States inquiring as to whether any lizards, snakes, turtles, frogs, toads, or salamanders are protected and, if so, in what fashion.

"Replies were received from every state and territory except Alaska, where presumably the herptile fauna is too meager to be worthy of consideration, and Mississippi, where the original letter and two follow-ups are still waiting for reply.

"Several interesting matters of nomenclature immediately arose. Your vice-president for conservation had innocently, but inaccurately, assumed that the words turtle and terrapin are synonymous in the vernacular. This is not so, for replies were received from certain states along the Atlantic seaboard to the effect that no turtles are protected, yet the diamondback terrapin is indigenous to said states. Further inquiry revealed that the diamondback is indeed protected, and why hadn't I asked about it the first time. In several instances the diamondback came under the jurisdiction of marine fisheries enforcement agencies to whom special letters had to be addressed. An interesting point concerning this phase of the investigation is that North Carolina no longer has a terrapin law. This reflects the rapidly waning interest in this reptile as a gustatory gem. Terrapin is still served in some of the hotels and private clubs in Philadelphia, which city a few decades ago was a large and important outlet point for the sale of *Malaclemys*. The demand now is slight, however.

"In New York, where the regulations obviously were drafted without the help of a zoologist, frogs are classified as quadrupeds and are officially included in the game laws. Tadpoles are not protected, however, since they are not quadrupeds.

"A few of the states and territories have laws or regulations theoretically giving complete asylum to certain reptiles. The desert tortoise may not be taken in Nevada; in California it may be possessed but not bought or sold. Molestation of nesting sea turtles and their eggs is prohibited in South Caroline, Georgia, Florida, and Puerto Rico. The large iguana, *Cyclura stejnegeri*, is protected administratively on Mona Island near Puerto Rico. New York protects land turtles, box and wood turtles and tortoises. California protects the diamondbacked terrapin, and here again is an interesting aspect of nomenclature, for *Malaclemys* is not indigenous to California and presumably the regulations are meant to apply to the Pacific pond turtle, *Clemmys marmorata*. Arizona protects not only the horned toad but also the venomous Gila monster.

"Twenty-seven states and the Territory of Hawaii control the catching of frogs by stipulating closed seasons, bag limits, or size limits. The dates vary widely, even in directly adjacent states. Most states specifically name the bullfrog, but other kinds are listed in some cases. In Colorado protection is given to a species known as the Louisiana Jumbo Frog, but, in the State of Louisiana itself, the closed season is for the Bullfrog and the Lagoon Frog. Standardization of common names for reptiles and amphibians, as well as for fishes, is still a long way from achievement, even though we in this Society have committees working toward that end.

"There is still a closed season for the diamondback terrapin in six states. Pennsylvania protects the redleg terrapin, which is *Clemmys insculpta*, from March to November. Several states regulate the sizes of meshes used for trapping aquatic animals. hence the smaller kinds of turtles and the young of larger kinds are permitted to escape.

"Louisiana controls the taking of what it calls the "Louisiana Native Lizard," and which is known to members of this Society as *Anolis carolinensis*. It may not be caught between the hours of 6:00 P.M. and 6:00 A.M. except for educational, scientific, or biological purposes and may be shipped out of the state only under permit.

"Both Georgia and Florida protect the alligator, and in Florida its sale is prohibited except under

permit. This has resulted in the importation of vast numbers of baby caimans for sale to tourists, most of whom subject such pets to lingering deaths or present them to zoos that do not want them. Last year approximately 200 young caimans were given to the Philadelphia Zoo alone.

"With the exception of Texas, most of the states and territories that have laws and regulations protecting reptiles and amphibians have approached the problem in serious minded fashion.

"No information is at hand to indicate how actively the various regulations are enforced. It is believed that most agencies conscientiously attempt to protect such reptiles and amphibians as are stipulated in their own areas of jurisdiction. Quite naturally, most of the laws are concerned with food animals, chiefly frogs and turtles. But it is also encouraging to note that a few species, such as the horned lizard, the desert tortoise, and the Gila monster are receiving protection for their esthetic value and not just because they are good to eat or provide leather for making hand bags. This is a step that all conservationists will applaud."

The Nominating Committee report was presented by REEVE M. BAILEY and, in due course, the following persons were elected for annual terms beginning January 1, 1957, to the offices indicated: President, EDWARD H. TAYLOR; Vice-President for Finance, JOHN C. MARR; Vice-President for Conservation, L. P. WOODS; Vice-President for Membership, A. P. BLAIR; Secretary, ARNOLD B. GROBMAN; Treasurer, COLEMAN J. GOIN; Publications' Secretary, N. BAYARD GREEN; Editor-in-Chief, FRED R. CAGLE; Ichthyological Editor, WILLIAM H. GOSLINE; Herpetological Editor, ROBERT C. STEBBINS; and Editorial Board, HENRY FITCH, DAVID L. JAMESON, ERNEST LACHNER, JOHN C. MARR, ROBERT M. MILLER, and JAMES A. OLIVER. The Secretary announced that by the time of the New Orleans meeting the Treasurer and himself will have served the Society for six years and they plan to submit their resignations at that time.

ROBERT MILLER read the report for the Committee on Zoological Nomenclature which had been prepared by WILLIAM FOLLETT. The report was:

"The present Committee on Zoological Nomenclature consists of ROBERT RUSH MILLER, JAMES A. PETERS, JAY M. SAVAGE, HOBART M. SMITH, NORMAN J. WILLIMOVSKY, and W. I. FOLLETT, chairman.

"During the past year, the Committee has completed its consideration of the following propositions, and has reported its consensus thereon to the International Commission on Zoological Nomenclature:

"1. The project to determine which, if any, of the herpetological names originally published in Oken's 1816 *Lehrbuch der Naturgeschichte* should be conserved if that work were to be suppressed for nomenclatural purposes was completed by DR. SAVAGE, and his report thereon was adopted as that of the Committee.

"2. A proposal to treat as a noun of the masculine gender every generic name having the final term *-branchus* (e.g., *Cryptobranchus*) obviously derived from the corresponding Greek word was approved.

"3. A proposal that the generic names *Desmognathus* Baird, 1850, and *Syngnathus* Linnaeus, 1758, be arbitrarily treated as nouns of the masculine gender was disapproved, and it was urged that each of these names be treated as of the classically correct (feminine) gender.

"4. A proposal that Bartram's 1791 *Travels Through North and South Carolina, Georgia, East and West Florida* be rejected for nomenclatural purposes was approved.

"The Committee continued its consideration of the nomenclatural problems arising from the taxonomic union of the genera *Ameiurus* and *Ictalurus*.

"A proposal that, despite the rule that the terminations *-i* and *-ii* are permissible variants without nomenclatural significance, a specific or subspecific name based on a personal name ending in *-ius* or *-ium* should invariably take the single *-i* termination, was referred to the International Commission's classical adviser.

"The unofficial interpretation of the former Rules, the 1948 Paris enactments, and the 1953 Copenhagen decisions, mentioned in the Committee's reports of the past two years, was issued by the chairman on September 3, 1955, as in unpublished document."

ROGER CONANT, Chairman, then gave a brief report for the Committee on Herpetological Common Names:

"Our Committee was appointed early in 1953 by CHARLES M. BOGERT, Past-President of this Society. The Committee was charged with the preparation of a list of common names for North American reptiles and amphibians suitable for use by zoo and museum personnel, other writers of labels, guide books, and popular handbooks, camp counselors, biology teachers, professional zoologists whose chief interest is not in herpetology, and anyone else who could make profitable use of such a standard list of names.

"HOBART M. SMITH was originally the Chairman, but when he resigned early in 1954, MR. BOGERT persuaded me to take over. Other members of the Committee consisted of the MESSRS. CAGLE, GOIN, LOWE, NEILL, NETTING, SCHMIDT, SHAW, and STEBBINS. MR. BOGERT, who stepped out of office as President in 1954, has continued to work in close cooperation with the Committee nonetheless."

The rest of MR. CONANT's report as given is not included here for it had subsequently been printed in *Copeia*, 1956, 3: 172.

REEVE M. BAILEY, Chairman of the corresponding committee for Common names of Fish, reported: "In recognition of an evident need, a set of objective principles to be employed in the selection of common names was drafted by the committee last year. This has been published in the Transactions of the American Fisheries Society (1955, Vol. 84: 368–371). Current efforts of the committee call for substantial increase in coverage of the list; the immediate emphasis concerns freshwater fishes. By 1958 the committee hopes to have prepared a revision of the original list of common names, which was published in 1948 (Spec. Publ. No. 1, Amer. Fish. Soc.)."

President RANEY then appointed a new Committee on Aquaria reflecting the increased interest of the Society in this subject. The personnel of the Committee is: CHRISTOPHER W. COATES, Chairman; E. S. HERALD; L. C. FINNERAN; F. G. WOODS; and L. CURTIS.

DR. RANEY also emphasized that the Society still has on hand 1400 copies of the Herpetological Check List and urged each member to serve as a committee of one to encourage sales. Copies may be bought from the Publications' Secretary for $3.25 each.

JOSEPH R. BAILEY, Chairman of the Resolutions Committee, then presented the following resolutions which were adopted by the Society:

"I. Whereas the 36th annual meeting of the ASIH has been successfully concluded, and, whereas the orderly and efficient conduct of the meetings and the several new pleasurable social and field events have been due to the careful planning and energetic efforts of the local committee and their wives, therefore, be it resolved that the ASIH express its deep appreciation to the committee members and their wives and extend high commendation to them.

"II. Whereas the Conservation Department of the State of Michigan by placing its Training School at Higgins Lake at the disposal of the ASIH has provided outstanding facilities contributing to the success of the 36th annual meetings, therefore, be it resolved that the ASIH express its gratitude to the Department of Conservation through its director, GERALD E. EDDY, and research administrator, JUSTIN W. LEONARD.

"III. Whereas the Fish and Wildlife Service of the U. S. Department of the Interior, presented such an informative motion picture and discussion of a fisheries problem of tremendous magnitude, and contributed in other effective ways to the success of the meeting, therefore, be it resolved, that the ASIH express its thanks to JAMES W. MOFFETT of the Service.

"IV. Whereas the Conservation Training School of the Michigan Department of Conservation, its facilities, and its operation have contributed so markedly to the success of the 36th annual meeting of the ASIH, and whereas, the hospitality of the station has been so genially extended by its director, therefore, be it resolved that the ASIH express its deep appreciation to our host EDWARD M. RAY, Superintendent of the Training School.

"V. On February the 13th the Society lost one of its founders, a former Editor of COPEIA, and Past President, with the death of EMMETT REID DUNN in Bryn Mawr, Pennsylvania. DR. DUNN, in his early sixties, was still the energetic worker and stimulating teacher that he had been over a period of nearly four decades. His numerous contributions to our knowledge of the Plethodontidae and the Caecilians, which laid the foundations for present day studies, together with his work on the amphibians and reptiles of the Americas, will stand as a monument to his energy and his keen intellect. His contributions will long endure, but those who knew DR. DUNN will miss his kindly counsel, his frank and honest criticism. Most of all we shall miss him as a highly esteemed friend and teacher."

Members of the local committee, who contributed so effectively to a most pleasant and efficient series of sessions included: Chairman, REEVE M. BAILEY; Program, CHARLES F. WALKER, C. L. SMITH, DAVID DELZELL, and LEE FINNERAN; Housing, KARL F. LAGLER and LEONARD ALLISON; Transportation, ROBERT R. MILLER and STAN LIAVENSE; Banquet, GERALD P. COOPER, CHARLES W. CREASER, JOHN VAN OOSTEN, and JAMES W. MOFFETT; Smoker, NORMAN HARTWEG; Projection, PAUL ESCHMEYER, CARL LATTA, and GEORGE WILLIAMS; Registration, STANFORD SMITH, SALAH EL ZERKA, and Mrs. PRISCILLA STARRETT; Photograph, LEONARD N. ALLISON; Excursions, DAVID SHETTER, VERNON APPLEGATE, LEONARD ALLISON, and ALFRED STOCKARD; and Ladies Entertainment, MRS. MARGARET HARTWEG and MRS. MARIAN BAILEY.

Most members left Higgins Lake after lunch with a tired but satisfied feeling of having enjoyed a pleasant and productive set of sessions.—ARNOLD B. GROBMAN, Secretary

American Museum of Natural History

DR. VLADIMIR WALTERS, newly appointed Assistant Curator of Fishes, is starting a study of the metabolic efficiency of large, fast-swimming fishes. This three-year project is sponsored by the ONR. Retired Curator, JOHN T. NICHOLS, still comes in

regularly and finds fishes in the Museum's collections worthy of study and description. Curator LESTER ARONSON of the Department of Animal Behavior has spent the summer at Cape Haze Marine Laboratory studying the behavior of local fishes. He is completing a paper on the ecology and behavior of *Fierasfer* (*Carapus*) and continuing his work on the endocrinology and reproductive habits of cichlid fishes, especially the *Tilapia* collected by him on his trip of West Africa two years ago. MR. DONN E. ROSEN and DR. MYRON GORDON of the Genetics Laboratory of the New York Zoological Society, located at the American Museum, are well under way in the preparation of a monographic taxonomic revision of the xiphophorin Poeciliids. This is the first part of an evaluation of the evolutionary relationships among the genera of the Family Poeciliidae that has been undertaken by MR. ROSEN. The laboratory continues to focus its attention on the genetics, embryology and physiology of the atypical growth of pigment and thyroid cells in special strains of platyfishes and swordtails, some of which have been maintained in captivity for nearly twenty years.

CHARLES M. BOGERT has completed a year's study in Mexico including Baja California and the southwestern United States. His studies on thermal regulation in amphibians and reptiles were carried on under a grant from the Guggenheim Foundation. He recorded the calls of many species of frogs.

RICHARD ZWEIFEL has studied movements of marked populations of red-spotted newts (*Diemictylus v. viridescens*) at Mountain Lake, Virginia. A five-week collecting trip to Mexico was planned to collect topotypic material of Mexican ranids and to obtain recordings of frog choruses.

New York Aquarium THE first stage of the new aquarium of the New York Zoological Society, located at Coney Island, is scheduled to be opened in May, 1957. In spite of all the preparatory work necessary to get the place in working order, Curator and Aquarist C. W. COATES has managed to make further studies on the electrogenic properties of the gymnotid eels and mormyrid fishes. Assistant Curator, JAMES W. ATZ, has just finished collaborating with DR. GRACE E. PICKFORD of the Bingham Oceanographic Laboratory of Yale University on a detailed review of the physiology of the pituitary gland of fishes. This two-volume monograph is being published by the New York Zoological Society. Pathologist ROSS F. NIGRELLI is conducting experiments on the transmission of lymphocystis disease in fishes, and is analyzing myxosporidian infections of the brain and eyes that occur in small tropical freshwater species. He is also continuing his studies of the numerous kinds of tumors in fishes.

News Notes AS the result of recent reorganizations, the teaching and research staffs of the former Franz Theodore Stone Laboratory at Put-in-Bay, Ohio have been transferred to the Ohio State University campus in Columbus. DR. MILTON B. TRAUTMAN becomes curator of the vertebrate collections of the Ohio State Museum, into which the fish collections of the Stone Laboratory have been incorporated.

In September DR. NORMAN J. WILIMOVSKY joined the research staff of the Alaska Branch of the U. S. Fish and Wildlife Service to take charge of the marine fishery investigations. His new address is Box 2021, Juneau, Alaska.

DR. DONALD W. TINKLE, recently awarded the Ph.D. degree from Tulane University, has accepted a position as assistant professor at West Texas State College. His doctorate dissertation is "The Systematics and Ecology of the *Sternotherus carinatus* Complex."

DR. ROBERT E. GORDON, assistant professor at Northeast Louisiana State College, has completed the requirements for the Ph.D. degree at Tulane University. His dissertation is "The Biology and Biodemography of the American Chameleon, *Anolis carolinensis*."

DR. GEORGE K. REID, JR. has left the Department of Wildlife Management at Texas A. and M. College to go to Rutgers University.

DR. JAMES A. OLIVER, Curator of Reptiles at the New York Zoological Park, is organizing field observations made on the reptiles of Trinidad on his trip in April of 1956. In collaboration with Staff Photographer, SAM DUNTON of the New York Zoological Park, he is making a colored movie on "The Prevention and Treatment of Snake Bite," which will probably be completed in 1957.

DR. ERNEST WILLIAMS, the newly selected Curator of Amphibians and Reptiles of Harvard's Museum of Comparative Zoology, is working on the *Anolis* of the West Indies. He is also collaborating with DR. MAX HECHT on a faunal analysis of the Cayman Islands.

THOMAS FRAZZETTA, a student at Cornell University, has spent the summer at The American Museum of Natural History working on the osteology of the skull in members of the Boidae. He is analyzing the kinetics of the skull in relation to the evolutionary history of the family.

DR. MAX HECHT, Instructor in Biology at Queens College, is currently studying eocene paleoherpe-

tological faunas and is collaborating with DR. ERNEST WILLIAMS on a faunal analysis of the Cayman Islands.

CARL KAUFFELD, Curator of Reptiles of the Staten Island Zoological Park, has just completed a popular book on his experiences collecting reptiles. This anecdotal account will be published by Doubleday and Company in March of 1957.

SAMUEL B. MCDOWELL, JR., a student at Columbia University working at the American Museum of Natural History, is completing a detailed study of the skulls of *Anelytropsis* and *Dibamus* to determine their relationships.

DR. JOHN A. MOORE, Professor of Zoology at Barnard College, is working on the classification of Australian frogs, emphasizing ecological and life history data. When in Australia recently on a Fullbright grant, DR. MOORE assembled more life history data than had been known previously for these frogs.

Check List of Amphibians and Reptiles

THE Sixth Edition, 1953, of "The Check List of North American Amphibians and Reptiles" is available from the Publications Secretary for $3.25. Many college and university libraries have not purchased this essential reference. Herpetologists can help make possible a new, revised checklist by encouraging purchases.

ASIH 1957 Annual Meeting, New Orleans

THE 37th annual meeting of the Society will be held at the Jung Hotel and Tulane University April 18–21. Members desiring to present papers must submit titles, time required, and equipment needs to FRED R. CAGLE, Zoology Department, Tulane University, prior to February 15. Room reservations should be made with MR. RODNEY BAKER, Reservation Department, Jung Hotel.

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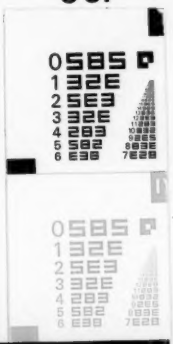
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